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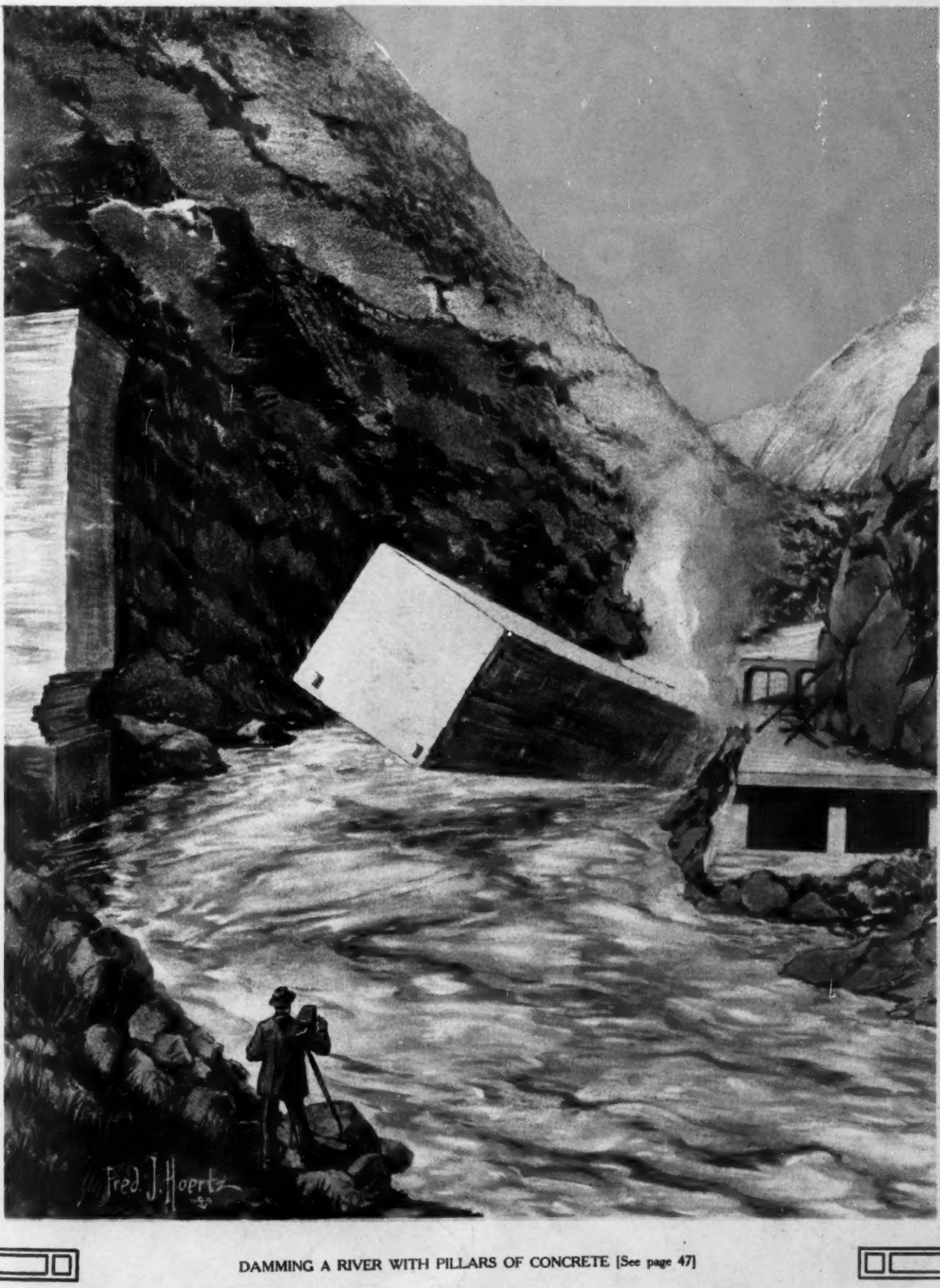

DAMMING A RIVER WITH PILLARS OF CONCRETE [See page 47]

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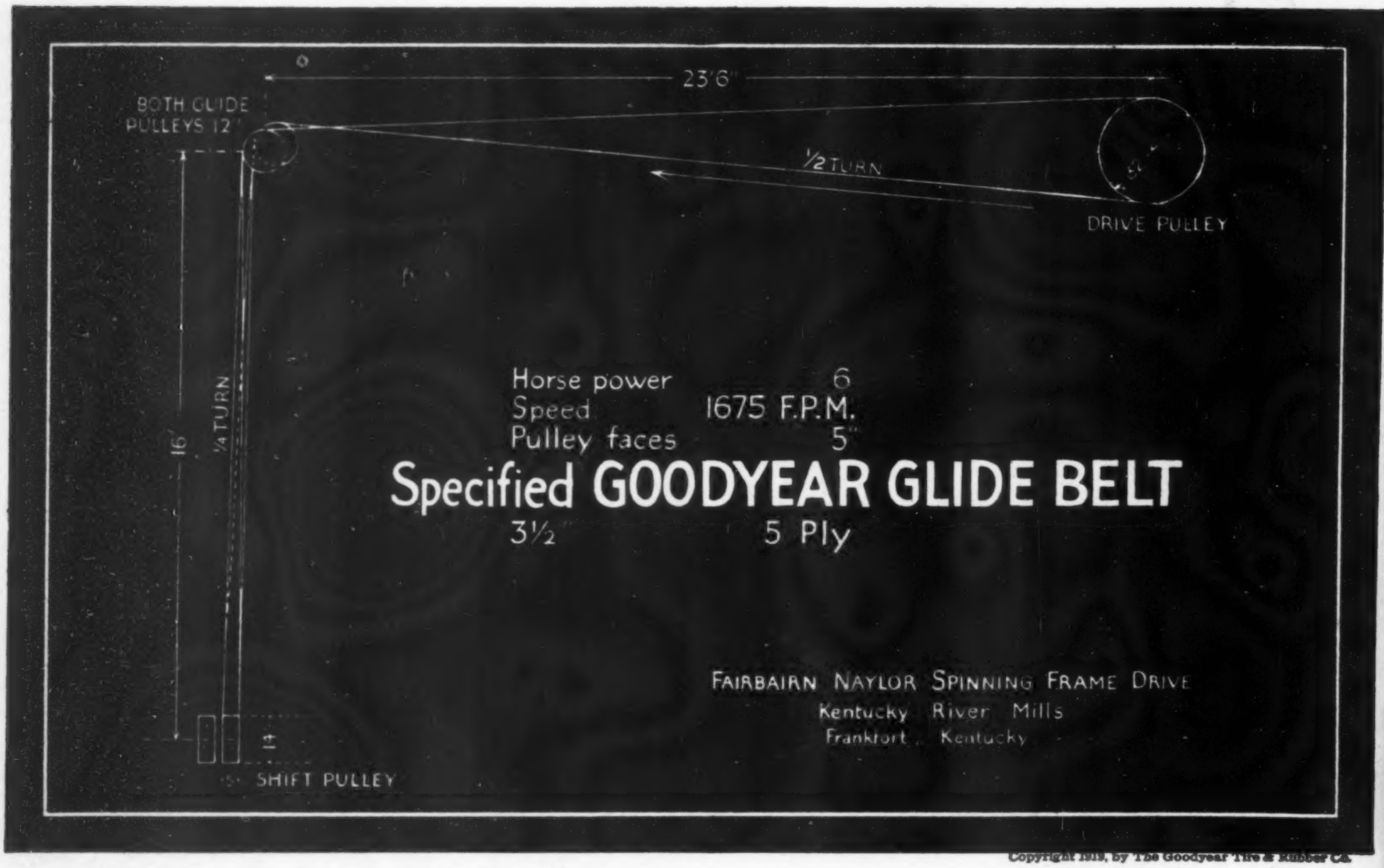

Fourteen Months—Half-Hour Shifts—and the G.T.M.

They had never kept belt records in the Kentucky River Mills at Frankfort, Kentucky. They always bought expensive belts and took the price as proof of quality. They were troubled sometimes by the frequent need for belt repairs, by their belting bills and by low production—but they just accepted all these things as necessary evils. One July day in 1917, a G.T.M.—Goodyear Technical Man—called. It was our Mr. Jenkins.

He asked Mr. Sutherland, the superintendent, to show him the hardest drive in this particular mill. Mr. Sutherland wanted to know why. The G.T.M. explained the Goodyear plan of selling belts only after a careful analysis of the drives to be served—and not as if a given belt were like a patent medicine and a sure-cure for any and all ills that drives may entail.

The idea appealed and he was shown the spinning frame drive. It was a shift—every half-hour the belt was thrown from one driven pulley to its twin. There was *one* quarter turn and *one* half turn. He measured belt speed, centers, pulley diameters and pulley faces, asked about the power, and noted the nature of the load.

Then he prescribed a Goodyear Glide Belt—3½ inch 5 ply. Mr. Sutherland was interested. He asked the price. He found it was so moderate that he doubted the merit of the belt, but consented to try it. He didn't see where he could lose anything, and he might be able to get rid of constant interruptions and shut-downs.

The belt was applied August 16, 1917, and is still running. *Its edges are not even worn.* No stretch has had to be taken out. Production has never been interrupted a single minute. Fourteen months after being applied the belt seemed still as good as new.

These fourteen months of perfect service, in spite of shifts every half-hour, on that spinning frame drive, have converted them to the Goodyear plan of belt buying—and to Goodyear Belts. They have made the mill a Goodyear-belted- and G.T.M.-served mill—like thousands of others.

If you have a hard drive, and have always accepted high belting costs and belt-troubles as necessary evils, ask a G. T. M. to call. One from the nearest Goodyear Branch will be glad to do so when next he is in your vicinity. His service is free—for the savings he effects for purchasers are so evident and material, that a gratifying volume from the plants served is sure to result within a few years.

THE GOODYEAR TIRE & RUBBER COMPANY, AKRON, OHIO

·BELTING · PACKING HOSE · VALVES

GOODYEAR

AKRON


"Return Loads will cut your Hauling Costs."
DIAMOND T
Transporting these return loads via "The Nation's Freight Car" further cuts costs through economy of maintenance and certainty of performance. And back of both stands Diamond T's thirteen years of REPUTATION
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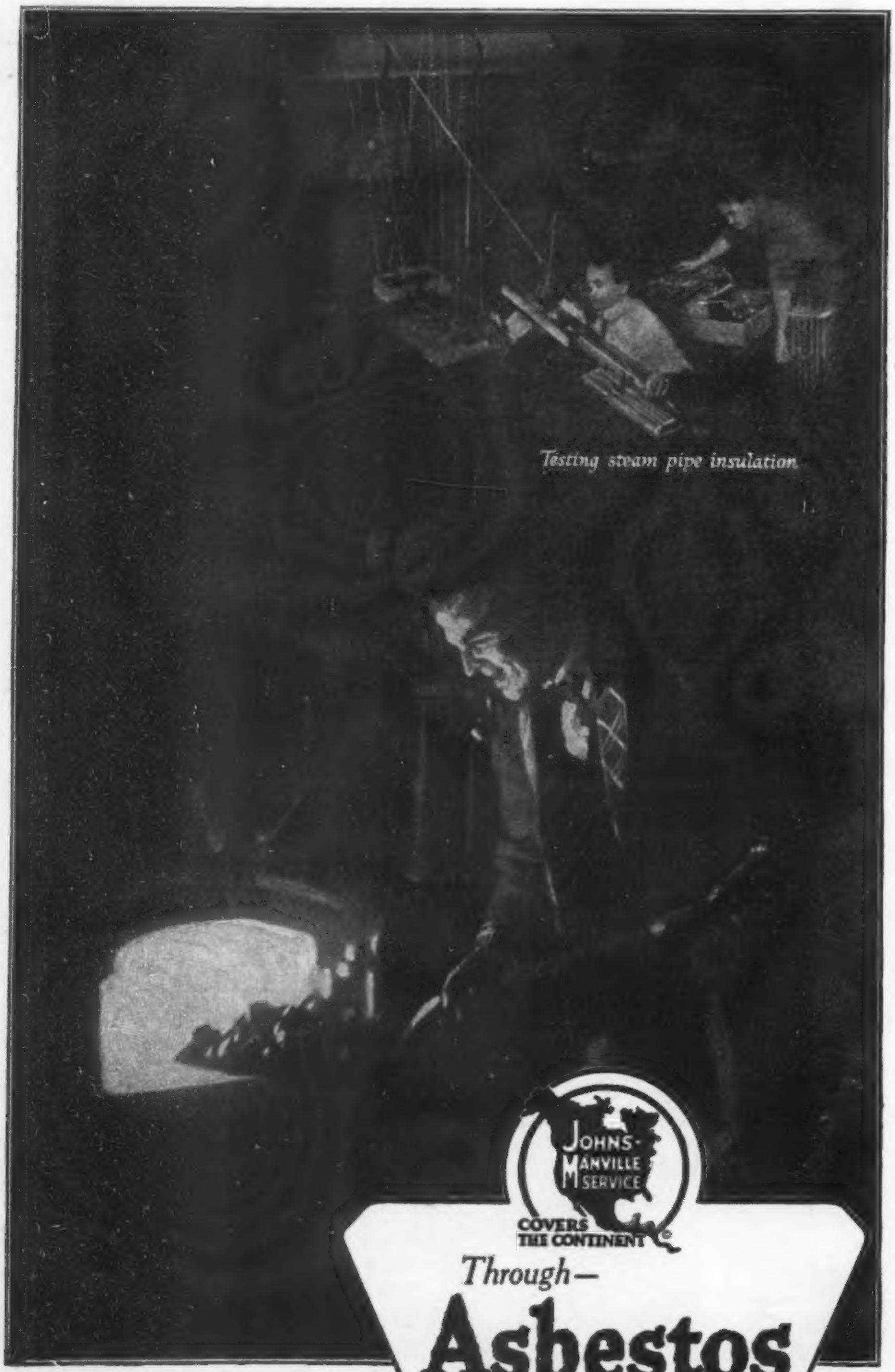

Testing steam pipe insulation

You can thank these men for some of the coal in your bin

PRECIOUS black diamonds! . . . How we appreciate them since our experiences of last winter. . . .

But few of us realize how science is saving coal for us. We know little of the engineers who have devoted a lifetime of study to successful methods of saving steam and heat; who, through the insulation of piping and other hot surfaces, have worked out great economies in industry.

Not only plant owners but the Government itself realizes what these men have done. During the last year the Fuel Administration has constantly emphasized in its Industrial work the tremendous importance of proper insulation. And as a result it is estimated that among our mills, factories and power plants over two and a half million tons of coal have been saved.

And these savings will continue throughout the years to come. More will be added to them. For coal wastes of ten years ago will never be tolerated again.

So, for some of the coal in your bin now and in the years to come you can thank, among others, Johns-Manville, who through their laboratory experimenters, by the development and application of asbestos, have perfected methods of heat insulation.

And this development of a *complete* line of insulation has enabled this organization to build up a broader service in heat and power saving than would be possible were that service controlled and centered merely on the sale of any *one* type of covering. Just another way in which Johns-Manville serves, not only industry, but the whole nation.

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and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
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that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Serves in Conservation

SEVENTY-FIFTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

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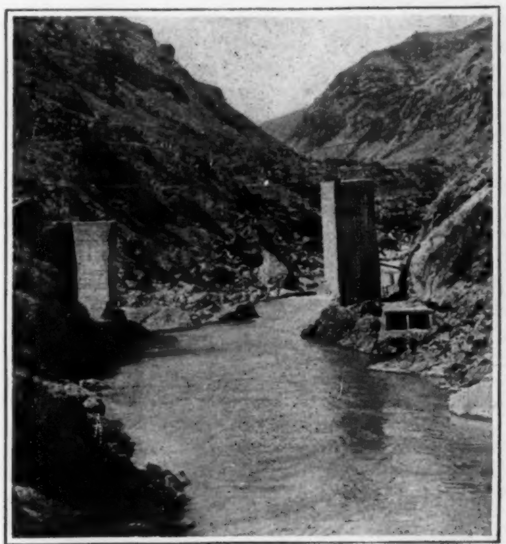
An Ingenious Irrigation Scheme

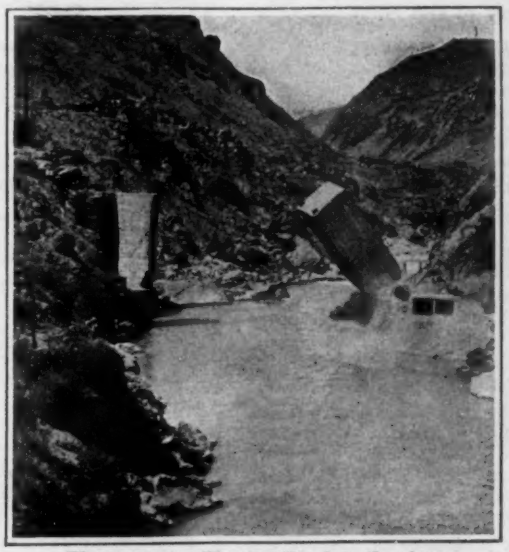
A NEW ZEALAND engineering concern recently conducted an interesting proceeding in the Kawarau Gorge, where two pillars had been constructed for the purpose of damning back the water. Each of the pillars is built of reinforced concrete. The column on the right-hand side of the river was 46 feet high and 16 feet square, and weighed 720 tons; that on the left-hand side stood 36 feet high and 13 feet square, and weighed 530 tons. The spot on the Kawarau where the river is to be dammed back is about four and a half miles from its junction with the Clutha at Cromwell, and a few hundred yards inside the entrance to the gorge. The river here is very rapid and narrow, running at the rate of 300 feet per minute. The banks are very steep, and the tops of the pillars were not on a level with their edges. The works undertaken by the Development Company necessitated the raising of the river, so that even at its lowest flow it would be high enough to run into the intake on the right-hand side, and thence flow down a race to the power-house. It was not considered possible to undertake the building of a weir in the usual fashion, owing to the precipitous nature of the sides of the gorge and the great volume of water, which has a fairly uniform depth of 17 feet.

On the pressure of an electric button the gelignite answered at once to the firing of the charge. The huge mass appeared to spring forward and lean slightly over as a tremor ran through its length. Momentarily it hung in the air, and then slowly bent and fell with a mighty crash into the river, the spray rising to a height of about 60 feet. From the time the explosion occurred till the pillar struck the water was just nine seconds. The pillar appeared to give a roll when it again came to view, and the water of the river surged back and then quickly resumed its onward flow, covering the obstruction. The pillar had apparently leapt out from its base as the explosion occurred, leaving a gap between its lower end and the bank of about 20 feet. When it came to rest and when the pillar had finally settled, it was seen that it was lying in a diagonal position, its top facing upstream.

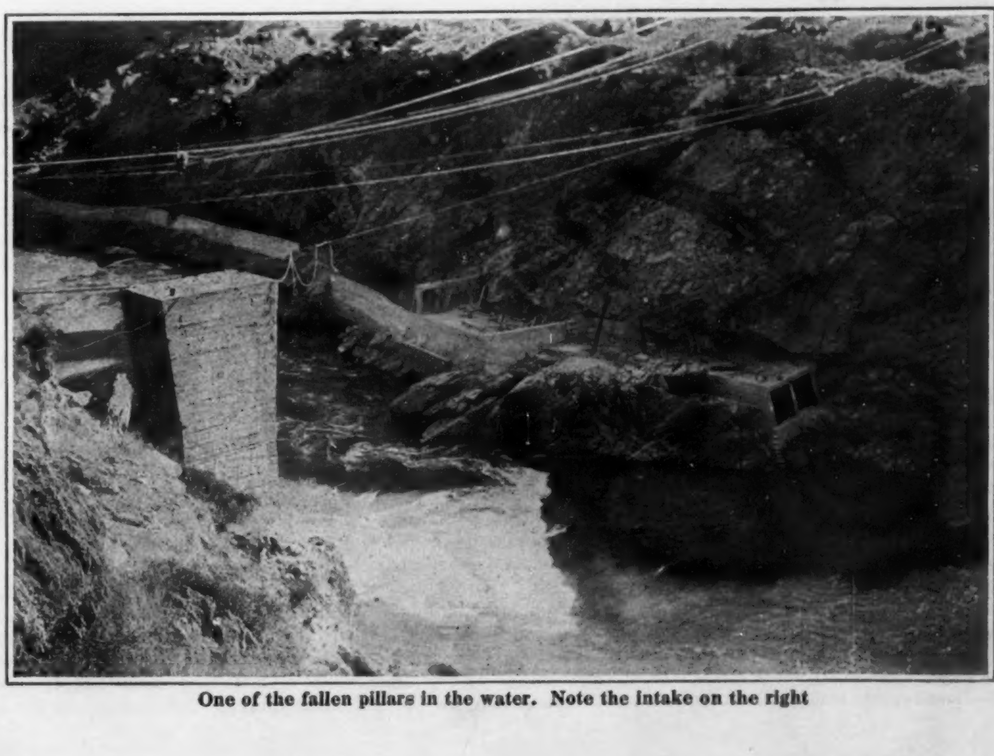
The company's engineer, on being interviewed after the falling of the first pillar, expressed his satisfaction at the way in which it had come to rest practically in the place which he had allowed for it. Since the pillar had fallen the river had risen 3 feet. It was lying just under the water. The intention was to back it up with 1,000 tons of mica schist. This blocking, it was anticipated, would silt up finally with sand, and the whole of the river would flow over the obstruction at a sufficient height to run comfortably into the intake. The river being thus raised, the fluming which is built for a distance of 30 chains on the right bank will be available to carry the water to the turbines which are to force the water from the river to a height of 180 feet through 2,240 feet of 30-inch pipes, and thus irrigate an extensive plantation.



Two monoliths ready for the explosion



The concrete pillar toppling into the river



One of the fallen pillars in the water. Note the intake on the right

Forest Fires of Spontaneous Origin

IT is usually assumed that forest fires, when not the result of a stroke of lightning are the result of carelessness on the part of lumbermen, campers, picknickers, or wayfarers. A French scientist, Mr. G. Raymond, denies this, and offers several interesting hypotheses in a brief article in *La Nature* (Paris) to account for spontaneous fires. He notes first that such fires always occur under the same conditions, namely, when the weather is dry, hot and *windy*, as for example, during the blowing of the "mistral" in southern Europe. To begin with, he considers it entirely possible that the dry and resinous branches of a pine forest might develop enough friction in a high hot wind to strike fire, the case being analogous to the method in which various savages obtain fire by a "fire stick." Again, minute drops of resin, spherical in form, might act as lenses to bring the sun's rays to a focus, thus setting fire to the inflammable materials around them.

A third suggestion is that since the ground of a pine forest, covered with needles and other decomposing matter, often acquires a very high degree of heat in the summer months, even a temperature several degrees above 100° F., there may result catalytic effects in the presence of impalpable resinous substances.

Lastly Mr. Raymond considers the effect of a possible engendering of frictional electricity in scraps of bark, pine needles, etc., driven hither and thither by the wind. It is indeed, a well known fact, that in the right weather conditions many persons can light a gas jet merely by pointing a finger at it, after shuffling rapidly over the carpet so as to develop a large amount of electricity through friction. Similarly the mere shaking of a blanket in the Sahara often causes it to emit a shower of sparks. Apropos of this the African explorer, Foureau, often mentioned the fact that during the blowing of the simoom in the desert his pocket compass was rendered utterly unreliable by reason of the electricity developed in its glass cover by the friction of the sand against it, driven before the burning wind. So it appears eminently reasonable to conclude that some, at least, of our forest fires may be attributed to such causes as these, and that locomotives and campers and lumbermen may be acquitted of universal responsibility.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

To the Secretary of the Navy

IN the SCIENTIFIC AMERICAN of December 28th, 1918, we made known the very gratifying fact that, with the elimination of the German Navy, the United States Navy moved up to second place. We showed also that because our allies lost many of their capital ships and stopped work, during the war, upon those they were building, our navy is so strong a second that it is equal in dreadnought strength to the next three navies, those of Japan, France and Italy, combined.

Our investigation showed that the United States possesses 19 dreadnoughts, Japan 9, France 7 and Italy 5. We found also that, because of the superior gun power, armor protection, and displacement of our vessels, our 19 ships were fully a match for the 21 ships of the three powers enumerated.

Our total of 19 completed United States dreadnoughts was based on a recent statement of the Chief Constructor to a Congressional Committee that we possessed that number. As a matter of fact, the Idaho is completed but has not yet had her trials; and the "California" and "Tennessee" are nearing completion and will be finished by the summer. It is fairly certain that all three ships will be ready for service by the time the Peace Plenipotentiaries have affixed their signatures at Versailles.

We are addressing this open letter to you, sir, because we feel that you owe it to Congress and the American people to explain why you presented to the House Naval Affairs Committee, and allowed to be published in the *New York Times*, the misleading statement of the naval strength of the Allies which appeared in the issue of that journal of December 31st, 1918. In the table presented, which we analyze on another page, you group the completed capital ships under three heads, viz., Battleships, Older Battleships, and Obsolete Battleships; and, because under the first heading, "Battleships," you assign 16 to the United States (this being the number of our completed dreadnoughts at the signing of the armistice) it is evident that you intend the American people to understand that the numbers assigned under that same heading to the respective navies of Great Britain, France and Italy, represent the number of completed dreadnoughts possessed by those nations.

As the result of your treatment of the statistics, the country is led to believe that Great Britain has 61 dreadnought battleships completed, France 20, and Italy 14; whereas the truth is that Great Britain has only 33, France 7, and Italy 5. So that in your effort to convince the taxpayers of the country and their representatives in Congress that our navy is inadequate, you give the correct figure for the dreadnought strength of the United States Navy, and exaggerated figures for the dreadnought strength of our allies. Your statement would make them believe the British dreadnought strength to be about double what it is, and the strength of France and Italy about treble.

Now, sir, we have a profound respect for the exalted and difficult position which you occupy in these perilous times; and we naturally and loyally jumped to the conclusion that these glaring errors were merely a slip of the pen. So we sought for an explanation of 61 being given as the total of the British dreadnoughts and found that it included the 21 predreadnoughts, or "older" battleships as you call them in your table, and even the 7 obsolete battleships of that navy. Now if we add 21 and 7 to 33 (the actual number of dreadnoughts) we arrive at your total of 61. Similarly, we find that Italy has 9 predreadnoughts, which number added to her 5 dreadnoughts gives us your total of 14.

We go thus into detail so that you may understand our perplexity; for it is evident that you had the full data before you in all its detail, not merely of our own navy, but of those of our allies; and what we are asking ourselves, and what the House Naval Affairs Committee and the country at large will not understand is why the Secretary of the Navy should give the true totals in regard to our own navy and incorrect totals as to the navies of our allies.

What the American people, naturally, want to know is: if a battleship is obsolete or old in our navy, why is its counterpart not obsolete or old in the navies of our allies? If Italy has 14 battleships, France 20 and Great Britain 61, by the same reckoning the United States has 39. Why, Mr. Secretary, do you thus confuse the issue by conveying the impression that 16 and not 39 represents the relative standing of the United States?

With the exception, possibly, of a few of the officers with whom you have surrounded yourself at Washington, we find that there is a practically unanimous conviction that the strength of the British Navy is warranted by her island position and the scattered condition of the British Empire, and that it is sufficient that we should be a powerful second. Particularly strong is this conviction among the officers of the battle squadron which you recently reviewed on its return from coöperation with the British fleet in the North Sea.

If there is any body of expert opinion that is qualified to judge whether the British fleet is a menace to the peace of the world, it is to be found, surely, among these American officers, who have spent a whole year with that fleet in the most intimate intercourse and coöperation. They frankly express their conviction that the British Navy is regarded both by officers and civilians of Great Britain as a purely protective force, built up and maintained for the sole purpose of keeping open the trade routes between Great Britain and her widely-scattered colonies.

Furthermore, the suggestion that the German fleet be sunk was prompted by the belief that an era of retrenchment for all navies, including our own and Great Britain's, was at hand. The elimination of the German fleet was regarded as the first logical step in this direction.

That this suggestion should have originated, as Admiral Rodman has announced, with himself and Admiral Beatty at the German surrender, proves that the thought and desire for retrenchment were already in the air.

Now that the public has been made aware of this fact, you will perhaps understand, Mr. Secretary, that your persistent advocacy, even before the peace conference has opened, of huge increases in the United States Navy has filled all thoughtful people, not merely among our allies, but here in America, with amazement and deep-seated concern.

This note of deep concern is sounded in an editorial on your attitude, in the *Washington Post* of January 3d, which says: No patriotic citizen wishes to hear any language at this time, or at any time, which is in its essence a manifestation of distrust of and latent enmity to one or more of the nations that have fought side by side with the United States against Germany. Yet Mr. Daniels is so lacking in discretion that he directs his utterances along these lines, at a time when President Wilson is straining every nerve to show the Allies that the United States sympathizes with them, and is anxious to have them all adjust their interests to the common welfare and peace of the world.

Theodore Roosevelt

THE SCIENTIFIC AMERICAN wishes to lay a wreath of mourning at the feet of the great man who has just passed away. While he lived, his passionate and fearless nature made him a host of friends and some enemies; but in this time of sorrow all alike, whether they are friends or foes, Republicans or Democrats, join in the desire to pay tribute to the man who was regarded as the first American Citizen, and whose loyalty and patriotism were like an ever-glowing fire. His fearlessness and hatred of wrong-doing, combined with his fundamental loveliness of nature, endeared him to the generation in which he lived, and will be an inspiration to those which are to come.

Reconstruction—With American Machinery

PRIOR to the war, the big manufacturing problem in this country was to reduce the cost of the finished product by means of labor-saving devices; for in American goods the cost of labor is always the outstanding item. In Europe, on the other hand, where labor has constituted a relatively small percentage of total costs, the installation of expensive labor-saving American machines has never met with much encouragement. It was the old story of the farmer and his hogs. A silvery-tongued agent had spent a couple of hours trying to sell a wonderful new feeder, which enabled the porkers to get outside a square meal in about one-tenth the time required when it was necessary for them to fight one another back and forth along the trough. When he had shot the bolt of his eloquence, his prospective customer remarked, "Waal, I don't guess my hogs' time is worth much money."

But the war has completely changed the conditions that surround the employer of European labor. As a special writer in the *New York Evening Post* recently pointed out, probably at no time in the history of our relations with Europe has American labor-saving machinery been in such demand as in the present period of reconstruction. European labor conditions, so far as wages are concerned, now more nearly approximate those of the United States than ever before. Already, this writer states, since the signing of the armistice numerous American makers of machinery who are properly protected in Europe have, within his knowledge, been approached by English and French manufacturers asking them either to ship machinery or to arrange for licenses under their existing European patents.

Europe, before the war, did not know what we meant when we talked of quantity production. But today new American machines are to be seen all over Great Britain and, in less degree, France. More important even than this are the American ideas that have taken root—ideas about the layout of machines in factories, ideas about the efficient using of unskilled labor through skilled planning, ideas of scientific management of all kinds. The great loss of labor through the war alone would make it essential for the European manufacturer and the European agriculturist to increase their per capita production. It is this necessity that is creating a demand for American inventions in Europe; for this country is the headquarters to which other nations must look for inventive development along labor-saving lines.

The meaning of this to us must not be overlooked. In the first place, it gives great promise of helping the solution of our own reconstruction problems. These have to do, not with finding enough labor to go around, but rather with the most advantageous employment of the labor which the war will release, and of the manufacturing facilities, multiplied even beyond our normal huge capacity, which it has bequeathed us. Our contemporary displays keen vision in its clear view of the possibilities here—possibilities whose importance is but suggested by the fact that already our manufacturers are crying aloud, through these columns and elsewhere, for peace-time products to keep their plants busy.

The situation has its call to the inventor, too. It were utter folly to suppose that labor-saving machinery has attained the height of its possibilities. In every direction it can be improved; in many industries it has not even been introduced save on the smallest of scales. For the inventor who can seize this opportunity and for the manufacturer who will seize it in company with him, the business of developing machinery for us to make and sell to Europe offers extraordinary allurements.

To Our Subscribers

OUR subscribers are requested to note the expiration date that appears on the wrapper in which they receive their copies of SCIENTIFIC AMERICAN. If they will send in their renewal orders at least two weeks prior to the date of expiration, it will aid us greatly in rendering them efficient service.

Engineering

The World's Record for Car Movement is claimed by Columbia, Pa., where, according to a recent report of the Director General of Railroads, 9,531 cars passed in a single day. In one month 250,000 freight cars passed Columbia, or an average of six cars per minute.

Gas Producer Built of Concrete Staves.—Owing to the high price and scarcity of steel during the war, a gas company in Syracuse found it necessary to build the shells of a 200 horse-power gas producer and scrubber out of concrete staves. The shells are eight feet in diameter and the staves measure 24 by 10 by 2½ inches. They are connected by tongue and groove joints. Between the concrete and the fire brick lining there is a three-inch space filled with a heat resisting material.

The Largest Tanker.—What is said to be the largest oil tanker in the world was launched at Wallsend-on-Tyne last month. The vessel has a length of 506 feet and a width of 68 feet 7 inches with a molded depth of 42¼ feet. This vessel, the "San Florentino," was built on the Isherwood system of longitudinal framing and was measured to pass both the Panama and Suez Canals. The ship's hull is divided into 13 compartments, and has 4½ miles of oil pipes. It is equipped with steam heating apparatus, a refrigerating plant, a hospital and a complete installation of auxiliary machinery. Compound geared turbines are used which may be run independently or be coupled to gearing to drive the propeller.

Caterpillar Road Grader in the Desert.—We have referred before, in this column, to the 17-mile tangent of Lincoln Highway which cuts across the Salt Lake Desert, shortening the highway by some fifty miles. This road is being built with desert soil as a base on which is laid a base course of gravel 5 inches thick with a surface course 3 inches thick. The desert surface is broken up by means of gang plows and shaped by means of road graders, hauled by caterpillar tractors. Owing to the nature of the soil some difficulty was experienced in moist weather due to the weight of the tractors which sank into the mud despite their broad bearing surfaces. The difficulty was solved by bolting timbers to the caterpillar belts so as to broaden the tread of the machines. As the road bed is completed the gravel is hauled and dumped over it by means of motor trucks mounted on broad steel-tired wheels which serve to pack the road material.

Helping the Salvor in the Shipyard.—When the race between the submarine and the shipyard was at its height it did not seem to occur to anyone that special provision should be made in the construction of a ship to render it easier for salvors to raise the ship in case it should be sunk. The submarine menace is now past, but even in time of peace, there is a considerable loss of vessels due to the elements, and to collision. One of the greatest difficulties that wrecking companies have to contend with is that of getting hold of a vessel which is completely submerged. Owing to the construction of a ship it is necessary to pass chains under it at various points as there is no provision for attaching chains directly to the framing of the ship. Why are not our ships designed with shackles affixed to the frame members at suitable points so as to simplify and expedite the work of the diver in making chains or cables fast to a wreck?

Repairing a Wooden Ship with Concrete.—A letter from Buenos Aires addressed to *Engineering* (London), describes some interesting work done in the repair of a wooden ship. The vessel, which is of 200 tons displacement, was purchased for the transport of stone and sand. On dumping stones into the vessel it was found that the bottom was weakened by the impact and leaked badly. Investigation showed that the wooden ribs had entirely rotted away for some three feet on either side of the keel. The bottom, however, was in good condition. Owing to the condition of the boat it was judged that it could not be docked by means of a slipway, which was the only means of docking available at the time. In this emergency new ribs of reinforced concrete were fitted into the spaces between the wooden ribs and at the same time the false keel was strengthened by running continuous concrete girders on either side of it. The work was done in a few days with the ship afloat in light condition. The repair gives every evidence of being a success. The concrete adds very little more weight than the ballast of old chains which had heretofore been used in the vessel.

Astronomy

Bright Night Skies in England.—The report of the Photographic Section of the British Astronomical Association for the year ending September 30th, 1918, comments on the unusual amount of light in the sky during the nights of that period. It has, says the report, been possible to read the face of a watch at all sorts of hours. The contrast of astronomical negatives has been much reduced. This illumination was not due to searchlights, nor did it seem to be auroral; moreover lighting in towns has been much reduced, under war regulations, so the cause remains a mystery.

New Ideas in Astronomical Observing.—A committee of the British Astronomical Association is known as the "Methods of Observation" Section. This body is trying to make as large a collection as possible of special devices and methods that members have found useful in their work, whether in actual observations or in the setting up and adjustment of instruments. The director, Mr. Maurice A. Ainslie, 8, Woodville Road, Blackheath, London, S.E., would doubtless welcome suggestions from non-members, also, as to useful "dodges." He proposes to publish shortly a list of points on which information is especially desired.

The Total Solar Eclipse of May 29th, 1919, will be comparable with the eclipse of last summer in the long stretch of continental territory covered by the path of totality, though not in accessibility of places along the path. The track extends across South America at its widest part, and also across equatorial Africa. The duration of totality will be exceptionally long (six seconds or more). The Carnegie Department of Terrestrial Magnetism, Washington, is planning to send two expeditions to favorable points. The director, Dr. L. A. Bauer, wishes to hear from other institutions planning expeditions, in order that arrangements may be made for systematic observations in terrestrial magnetism, atmospheric electricity, and kindred features of the eclipse.

Variations of Mira Ceti.—Several recent series of observations of the varying brightness of Mira Ceti, accompanied by light-curves, are published in *L'Astronomie* for last October. M. Felix de Roy, the Belgian astronomer, places its last maximum at October 2d, 1917, with a brightness of 3.4 mag. on the Harvard scale. The previous maximum was November 5th, 1916. The last minimum could not be observed, on account of the proximity of the star to the sun. The increase from minimum to maximum was regular and very rapid; the subsequent decrease was more gradual and irregular. The dates assigned by other observers to the recent maximum range from October 5th to October 15th. The date previously calculated was October 21st.

A Short Period Variable Star in Andromeda.—Miss F. Mabel Ashall, a graduate student of the University of Toronto, has recently discovered a variable star in Andromeda, R.A. 22 h. 49 m., Decl. N. 37 deg. 23 m., having the remarkably short period of 3 h. 50 m. 55.1 s. The range of variation is small, being only from about 9.18 to 9.88 mag. This variable was discovered in the examination of a number of plates from Harvard College Observatory, and a further examination of plates, extending over a period of 26 years, made by Miss H. S. Leavitt, has revealed the fact that during 1913 the period of variability changed suddenly, becoming longer by 0.17 sec. The light curve shows a gradual decline in brightness and a similar gradual increase, with no evidence of a secondary minimum.

The Twenty-second Meeting of the American Astronomical Society was held at Harvard College Observatory August 20th-23d, with an attendance of about fifty. The programme of papers was unusually large, and a considerable number of these dealt with the solar eclipse of last June and the new star in Aquila. An active discussion took place over the question now prominent in the astronomical world of the time of beginning of the astronomical and civil days. A resolution was adopted in favor of beginning both at midnight and numbering the hours from 0 to 24. A similar resolution has been adopted by the Royal Astronomical Society, and the project is favored by the British and French naval authorities, so the prospects are that this long-mooted reform in timekeeping will soon be put into effect. Prof. E. C. Pickering was elected president of the society for the coming year.

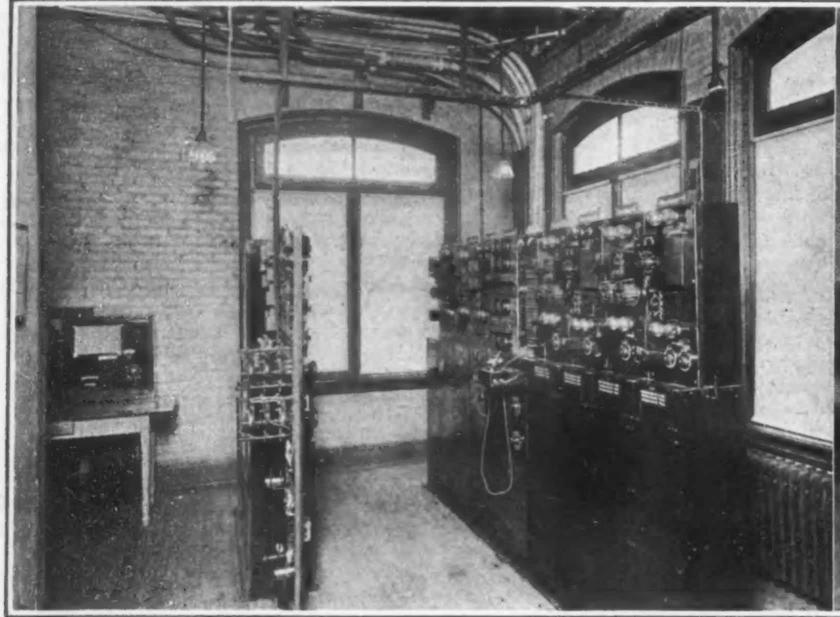
Automobile

Post-War Models in England.—There is considerable speculation in England as to what kind of cars will be offered by the manufacturers now the war is ended, for it is a generally accepted fact that the designers of that country have been making careful note of the operation of all kinds of cars used by the armies with a view to future radical changes and improvement. However, the sudden ending of the war, and the fact that all of the car builders were full up with government work until the last minute, and not yet free, will make it impossible to get out any new models for this season, and the real "post-war" car is not expected to make its appearance until next fall. Practically the same manufacturing conditions prevail in this country, but no such radical changes in models have been predicted here as are rumored for the British makers.

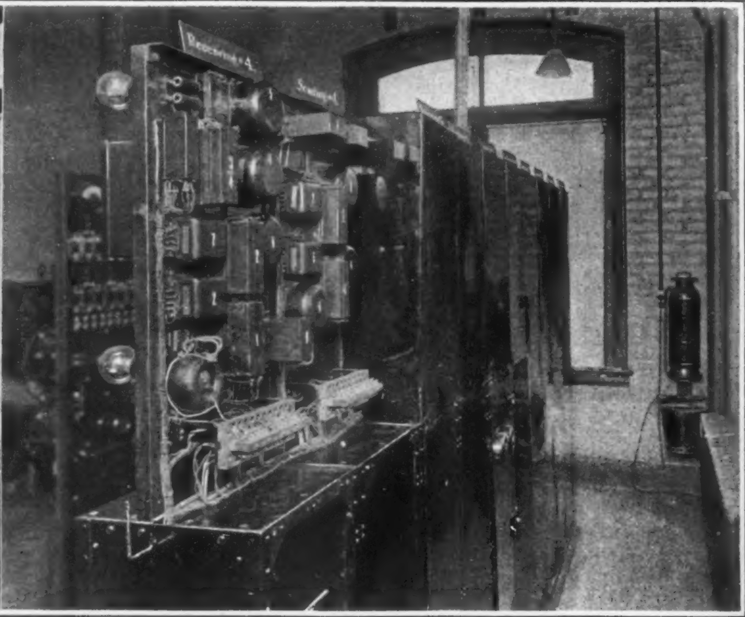
Rubber Water Connections.—When cleaning out the radiator it is well to occasionally inspect the condition of the rubber hose connections in the water circulation system, for obstructions not infrequently develop at these places. If a glycerine anti-freezing mixture has been used, or any kind of radiator dope, the interior of these rubber connections is very likely to be injured, as many of these substances so affect rubber that the interior surface of the connection is softened and loosened; and the vibration of the car is liable to cause pieces of rubber to break away. When this occurs the loose pieces lodge at the narrow points in the passages and seriously diminish the flow of the cooling water. Whenever one of these rubber connections feels soft and flabby, or appears to have breaks in the body of the tubing, the connection should be removed and carefully examined and at the same time the passage should be tested to see that the flow of water is not obstructed.

Care of Radiators.—Out of sight, out of mind, is a saying as old as the hills, and as true today as it ever was; and it is particularly applicable to the car radiator. No one ever sees the inside of the radiator, and consequently, as long as the outside looks well and there are no serious leaks, it is taken for granted that the device is all right and performing its function properly. Some kinds of water form a deposit in the radiator and water passages, and this is all the greater if the water used is dirty, with the result that the circulation is retarded and the engine runs hotter than it should. As the radiating surface is designed in suitable proportion to the size of the engine, in order to maintain proper operation the radiating surface must be kept in efficient condition, and this means the inside as well as the outside. A satisfactory way to clean out the deposits within the radiator is to make up a solution of one pound of washing soda in two gallons of hot water. This is poured into the radiator, which is then filled up with plain water and the engine is then run slowly for half an hour, when the soda solution is entirely drained off, and the radiator refilled with clean water. This cleaning out should be done several times a year, and more particularly where the thermo-siphon system is used.

Anti-Freezing Mixtures.—During the winter season great care must be observed to keep the cooling system of an automobile from freezing, and to assist in this many anti-freezing mixtures have been offered to owners of cars. The U. S. Bureau of Standards has made an exhaustive investigation of the subject, and its conclusion is that the most satisfactory material to use, which will not injure either the radiator, engine or the rubber connections, is alcohol mixed with the cooling water in sufficient quantity. For a temperature of 27° F. a 10 per cent solution of alcohol is required; for 10° F., 30 per cent; for—2° F., 40 per cent and for—18° F., a 50 per cent solution. The best way to make up the proper strength mixture is to use an hydrometer, and the specific gravities shown by the instrument for the above temperatures are respectively 0.988, 0.968, 0.957 and 0.943. Of course the alcohol boils off quite rapidly, and the cooling medium must be tested and more alcohol added every few days, but it appears to be the only safe system. Glycerine is sometimes added to reduce the loss of alcohol, but in effective quantities it attacks the rubber connections seriously; and calcium chloride solutions, so often recommended, are decidedly corrosive, especially on the soldered joints of the radiator and on aluminum or alloys that are often used in manifolds, pumps, etc.



General view of the multiplex apparatus now used between Baltimore and Pittsburgh



Rear view of one of the multiplex racks with covers removed to show parts of the apparatus

Two views of the multiplex apparatus now employed for increasing the carrying capacity of telephone lines

Getting More Messages Over Our Wires

How the Traffic Capacity of Telegraph and Telephone Circuits Has Been Increased Three-fold

THE new system of multiplex telephony and telegraphy recently announced in the daily press is the result of several years of intense effort. By its application it is now possible to increase many-fold the message-carrying capacity of long-distance telegraph and telephone lines; indeed, the new system marks an epoch in the development of trans-continental communication.

The new multiplex system, which has been in actual use between Baltimore and Pittsburgh for more than two months with entirely satisfactory results, is the recent practical application of the work of the technical staff of the Bell organisation. It permits four telephone conversations to be carried on simultaneously over one pair of wires, in addition to the telephone conversation provided by the ordinary methods. That means that over a single circuit a total of five telephone conversations are simultaneously transmitted, and in each the service is as good as if the circuit were carrying, in the ordinary way, a single conversation.

A number of years ago the Bell engineers developed the "phantom" circuit arrangement by which telephone circuits are obtained from two pairs of wires. This is an improvement and has been extensively used, but heretofore it has been impossible to carry over a single pair of wires more than one telephone conversation.

Now it is possible by the multipex method to utilize a single pair of wires for five conversations, while two pairs of wires, which heretofore had a maximum of three conversations with the aid of the "phantom," may now be multiplexed to carry ten simultaneous conversations. This amounts to an increase of more than three-fold in the telephonic carrying capacity of the wires, as compared with the best methods previously known to the art, and an increase of five-fold in the capacity under conditions where the "phantom" circuit is not employed.

The new multiplex system makes use of alternating currents whose frequencies occupy a range between the frequencies of the ordinary telephone currents, which are those of the human voice, and the lowest frequencies which are used in wireless communication. This frequency range has not heretofore been commercially used. It is interesting to note that under favorable conditions the whole range is audible to many, and the lower part of the range is audible to anyone with normal hearing. It is found that frequencies within this range are high enough to be used as "carriers" of ordinary telephone currents, and yet with proper arrangements can be transmitted over long telephone lines without the large transmission losses and large interference between circuits which would be brought in by higher frequencies.

Each additional circuit in the new system makes use of some frequency within this range. At the sending end of each circuit the ordinary telephone currents are made to modulate this "carrier" frequency, so that the amount of the "carrier" frequency sent out on the line varies with the amplitude of the ordinary telephone currents. At the receiving end the "carrier" current is put into a demodulating circuit which then gives out the original telephone current.

The different circuits are kept separate at each end by inserting in each circuit a combination of impedances which make up an electrical "filter." This transmits the range of frequencies peculiar to that circuit and stops all other frequencies. An important difference should be noted here between this system and wireless systems, in that in wireless working it has been generally sufficient to send and receive in "tuned" circuits. In the multiplex system, however, tuned circuits would not be sufficient since each telephone channel occupies a range of frequencies of about 2,500 cycles and any circuit tuned to these comparatively low frequencies would be too selective to receive such a range properly.

Vacuum tubes are used in the modulating and demodulating circuits, and are also used as amplifiers in the transmitting and receiving branches and at intermediate points along the line where necessary, in order to prevent the currents from becoming too highly attenuated.

The underlying principle may be illustrated by considering a composite photograph of five individuals. Given such a composite photograph of the ordinary kind, it would obviously be impossible to derive from it the picture of each of the five individuals going to make it up. If, however, the composite photograph had been made up in five different colors, the picture of each individual being in different color, say, one red, one blue, one green, one yellow, and one violet, it would then be possible, by looking at the picture through colored glasses, to see any one picture, separate from the others. If red glasses were used, the picture printed in red only would be seen, if blue glasses the picture in blue, and so on; although when looking at it in the ordinary way all of the pictures would be seen together and only the combination would appear. As the tint of each picture serves as a means of differentiating it from the others, so does the frequency of the "carrier" currents serve to differentiate each of the conversations in the new telephone multiplex.

Sensational results have also been attained in telegraphy by the new multiplex system. A single pair of wires combined into a metallic circuit of the type used for telephone working, by the application of the Bell System's new apparatus and methods, will have an enormously increased capacity for telegraph messages.

As applied to high speed printer systems, the engineers find they can do eight times as much as is now done, and as applied to the ordinary duplex telegraph circuit in general use, they can do ten times as much. These increased results are attained without in any way impairing the telegraph traffic.

Moreover, the nature of the developments permits the same wires to be used partly for telephone and partly for telegraph purposes. This means that a pair of wires is available either for five simultaneous telephone conversations or for 40 simultaneous telegraph messages, or partly for one and partly for the other.

There have been numberless attempts by inventors, scientists, and engineers, from the earliest days of both the telegraph and the telephone, to develop methods for the multiplex transmission of messages. Dr. Alexander Graham Bell was working on the problem of multiplex telegraphy when he had his first conception of the structure of the original telephone. It is significant that the Bell organization which has been and is working continuously to perfect the telephone and extend its usefulness, has accomplished not only multiplex telephony but multiplex telegraphy, Dr. Bell's unsolved problem of 40 years ago.

Notwithstanding the fact that there were no conclusively practical results from the early efforts in this direction, it is nevertheless true that some of the undertakings of the earlier workers in this field have been of suggestive value at least in the working out of the problem. As an instance, there is a suggestion made by Major General George O. Squier, Chief Signal Officer of the U. S. Army, about ten years ago, which attracted very general attention. Likewise, Dr. Lee DeForest working in entirely different fields and with a different objective, a number of years ago, invented a wireless device known as the audion, which by the improvements and adaptation of the telephone engineers has been made an important part of the new system.

While the new multiplex system is physically adaptable to short lines, practically, from the nature of the apparatus and methods employed, it is not advantageous on lines of much less than one hundred miles. On longer lines its application will be extended immediately, but its introduction must necessarily be gradual on account of the nature of the apparatus required and the rearrangement and adaptation of the lines themselves and their associated apparatus to the new methods of working.

The new multiplex system as it is now applied to the telephone is a means of increasing or multiplying transmitting capacity of long lines, requiring no change in the subscribers' telephone or in the terminal switchboard operation. It is quite as applicable to transcontinental lines as to any other long-distance service.

The "Eagle" Boats

THE Ford "Eagle" boats, of which we are hearing so much just now, were designed for anti-submarine service—work for which we have always considered them to be too small. Line officers would have preferred a larger craft, and we believe that if our naval constructors had had their way and been left entirely free in the matter, they also would have designed a larger boat with better sea-keeping qualities. How far Mr. Ford had to do with the design we do not know, but we do know that speed of construction was a controlling consideration. Hence the framing and the general lines of the ships were drawn so as to reduce bending and general working to a minimum. They have straight wedge bows and no flare. Consequently, they would be in trouble driving into a head sea or running before a following sea, in which latter case they would be very difficult to steer. Either the construction of any more of these boats should be abandoned, or the design should be modified to give them better sea-keeping qualities.

What Machinery Is Doing for the Walnut Industry

How Production Is Enlarged, Prices Stabilized, and Wastes Eliminated

By Howard C. Kegley

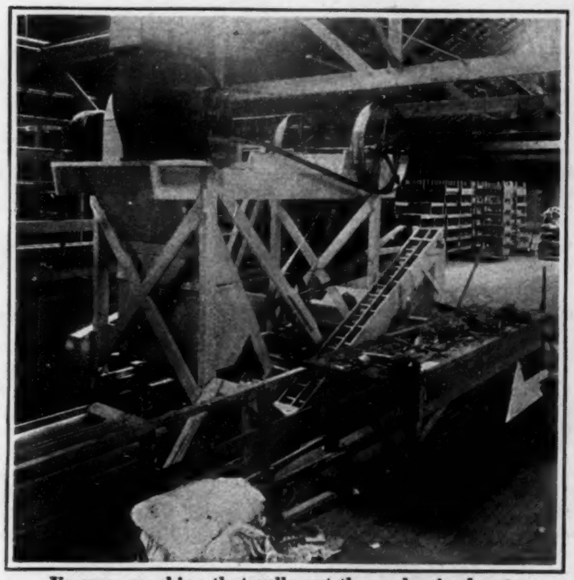
A FEW years ago when the English walnut growers of California formed a coöperative association and began marketing their own product they found a big obstacle in their way. That obstacle was the cull—the under-developed, discolored or scrawny nut. It stood in the way of standardization of two excellent grades. The people had been accustomed to walnuts at 10 cents per pound, and they couldn't see that any nut was worth more than that. Nut peddlers had been in the habit of buying up quantities of culls, topping them with a few high grade nuts and spoiling the market with them.

At the outset the growers' association decided that it would have to eliminate the cull in order to prove to the public that there was something better—something worth at least 20 cents per pound. So the first year of scientific marketing the cull was taken off the market. It had previously been sold at about five cents per pound. At the outset the association undertook to crack it and sell the meat for use in candy stores and bakeries. The going was a little slow and the culls didn't pan out profitably the first year, but the first and second quality nuts brought good prices, so the growers counted that they were ahead of the game.

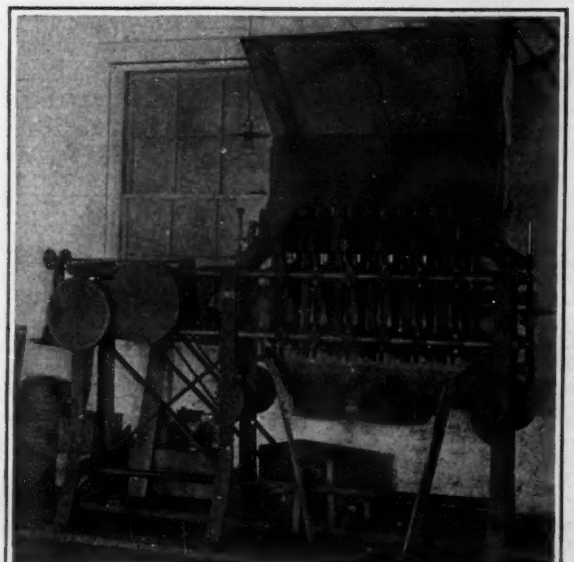
A careful study of conditions and requirements showed that the association needed to get at the cull business on a bigger scale, so the contracts were made to read that all growers had to deliver their entire output of culls to the association storehouses, virtually taking the cull out of the market. Then members of the association invented three machines which did away with hand-cracking, provided a method of separating the good nuts from the bad ones and finally made it possible to extract the last morsel of meat from the shells of the cracked culls.

Today the walnut growers' association has revolutionized its business to the point where it gets from 20 to 25 cents per pound for number ones and number twos, and sells its nut meats for from 25 to 45 cents per pound. And the singular thing about it is that it cannot get enough of the meats to supply the demand. This is due to the fact that the meat of the English walnut grown in the United States is plumper, larger and whiter than that of the nuts grown in southern Europe. In two years the southern California walnut meats completely crowded the imported walnut meats out of the market in this country.

The invention of the three machines which is used in transforming the cull into an article which is in big demand made it possible to use every bit of the cull for commercial purposes. In the packing houses of Chicago it is said that they extract from the pig everything but the squeal. In the walnut packing house they equal this performance. Even the shells are sold; they are used in place of cornmeal, as a carrying vehicle for dynamite, and the association sells all of its cull shells at $10 per ton. In the matter of winning



Vacuum machine that culls out the undersized nuts



This machine cracks but does not crush the nuts

the war, it can be seen, the English walnut has done its bit along with other products of the soil which are considered more vital in times of war.

Probably the most important of the mechanical devices used in the walnut cull factory is the cracking machine—a device invented by one of the association members, and sold to the organization. It has a capacity of five tons of nuts per day, and four of the machines keep 200 women and girls at work separating the meats from the shells and grading the meats.

This machine has a nut hopper at the top. The nuts drop from holes in the bottom of the hopper, into cylinders, going in one at a time. The cylinders feed them one at a time in between long iron fingers. The finger device is operated by cam wheels. At one stage of the cracking operation the fingers are just far enough apart to admit a walnut with its end perpendicularly. When the walnut has dropped between the fingers until it fits snugly, the cam wheels turn around to the point where their leverage shoves the right hand set of fingers over against the left hand set with a quick motion, and that motion exerts just enough energy to snap the shells of the nuts without exercising any slow pressure which would tend to pinch or crush the meats. Then as the cams turn over again the fingers are allowed to spread apart, and the nuts drop into sacks which are hung over the mouth of the chute below the machine.

The adjustment of the machine is so nearly perfect that it cracks at least 85 per cent of the nuts without injuring the meats in any way. The 15 per cent of damaged meats come from extra large or unshapely nuts which do not conform to the size of the space between the cracking fingers and consequently get too much squeeze when the machine is in motion.

One of the biggest problems that confronted the association when it undertook to separate the culls from the high grade nuts was that of weeding out the lightweights—the nuts with only one mature half, or those which had shriveled meats, or moldy meats, or were otherwise unfit to go into the two best grades.

It was necessary to eliminate these inferior nuts in order to establish firmly the quality of the better grades in the open market.

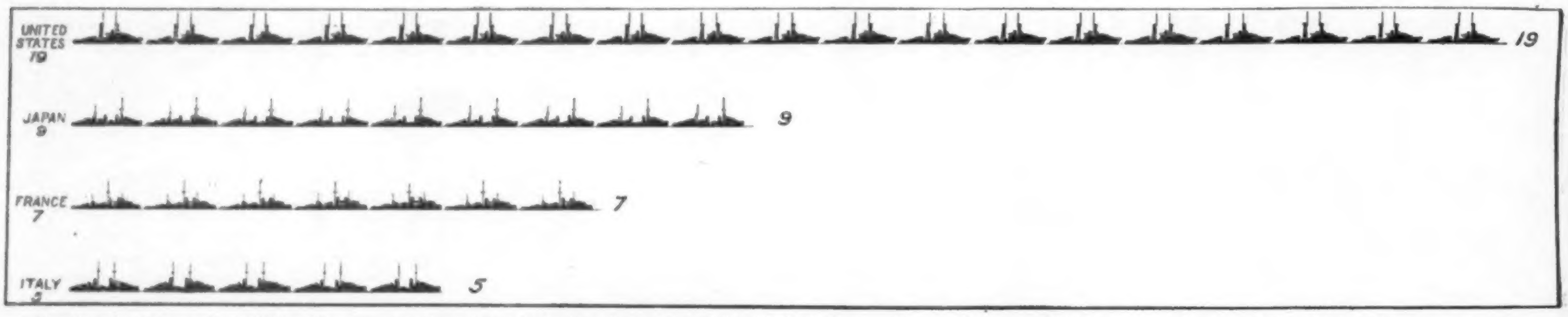
This difficulty was overcome by the use of a vacuum machine invented for that particular purpose. The device works on the principle of the vacuum cleaner, and it lifts from among the high grade nuts all nuts which are light in weight and therefore of questionable quality. When it has finished its work the association is reasonably sure that every nut it has left in the two best grades is a sound nut with plump meat.

The nuts are conveyed to the vacuum machine in a narrow elevator at one side of the machine. The elevator belt is pocketed to keep the nuts from piling up and overflowing the elevator track. When they are dumped into a trough at the end of the elevator

(Continued on page 62)

The girls separate meat from shells, as the cracked nuts pass out of the big hoppers upon and along the table chutes beneath

Feeding the shells into the machine which finds the small pieces of meat that the girls have overlooked —fifty dollars' worth a day



This sketch shows what will be the comparative strength in dreadnoughts of the United States, Japan, France and Italy at the signing of the Versailles Peace Treaty, when our dreadnought fleet will be equal in power to those of the next three nations

Battleship Strength of the Five Leading Naval Powers

Analysis of the Standing of the Allied Navies in Dreadnoughts, Predreadnoughts and Battle-Cruisers

THE end of the world war finds the Allied powers war-weary and eager for relief from the burden of maintaining huge armaments both on sea and land. Americans returning from the other side, whether they be officers of the army or navy, or civilians, tell us that all of our allies, now that the German threat is gone, are prepared to make a *pro rata* reduction of their armaments, based upon their several national necessities, and it is confidently believed that the determination of the relative future strength, both on sea and land, will be mutually and amicably adjusted at the forthcoming peace conference.

In 1914, the leading naval powers were in the full swing of that burdensome competition which the aggressive activity of Germany had imposed. Every leading navy had an important program of naval construction on hand and in 1916 the United States also, foreseeing the possibility of its eventual entrance into the war, sanctioned in a single program an addition to our fleet greater than had ever been voted by any naval power in all the history of naval shipbuilding. To Great Britain was assigned the task of holding within its harbors or defeating in the open the powerful German fleet, and with a view to providing for future losses and making sure of having at all times a sufficient preponderance of power in the North Sea, the British shipbuilding yards, both governmental and private, were instructed to rush the uncompleted ships of the 1913 and 1914 programs to completion.

The other members of the Entente, France, Italy, and Japan, realizing that they were sufficiently strong in battleships and battle-cruisers to take care of the fleets of Austria and Turkey, practically ceased all work on their capital ships and concentrated upon unarmored ships of the scout, destroyer and submarine type. All of the Allied navies, particularly that of Great Britain, suffered heavy losses during the war. Great Britain has lost two dreadnought battleships, eleven predreadnought battleships, three battle-cruisers, eleven armored cruisers, two second-class cruisers, eight light cruisers, and over forty destroyers. France has lost a semi-dreadnought battleship, three predreadnought battleships, three armored cruisers, a protected cruiser, and eight or ten destroyers. Italy has lost one of her finest dreadnought battleships, three predreadnought battleships, and half a dozen destroyers. Japan is short an armored cruiser, two light cruisers, and a destroyer, and the United States has lost an armored cruiser and several destroyers.

The lifting of the censorship makes it possible to give in detail a statement of the present strength of the navies of the world and to include in this the new ships which have been built during the war.

It should be noted that because of the limitations of space, our tables on the accompanying page include only capital ships, that is dreadnought battleships, predreadnought battleships, and battle-cruisers.

The British Navy

At the date of the signing of the armistice, the battleship strength of the British navy consisted of 33 dreadnought battleships, 21 predreadnought battleships, 7 obsolete battleships, and 9 battle-cruisers. For reasons best known to himself, Mr. Daniels, Secretary of the Navy, in recent tables presented to the House Naval Committee, credits the British navy with no predreadnoughts or obsolete battleships, but lumps all three types together as dreadnought battleships.

The capital ships completed during the war and included in the Grand Fleet consist of three dreadnought battleships, the "Benbow," "Emperor of India," and "Marlborough," of the "Iron Duke" class, ships of 25,000 tons, mounting ten 13.5-inch guns. Also, the "Agincourt," a ship which was laid down in 1911 at Ellswick for the Brazilian government. In January 1914, she was sold to Turkey and on the outbreak of war, being still in the builders' hands, she was taken over by the British navy and named "Agincourt." She is notable for the fact that she carries fourteen 12-inch guns in seven 2-gun turrets. Her displacement is about 28,000 tons. Another new ship is the "Erin," built by Vickers for Turkey, and taken over for the British navy at the outbreak of war. She is of 23,000 tons displacement and mounts ten 13.5-inch guns. Still a third ship taken over is the "Canada" of 28,000 tons, built at Ellswick, for Chile and known as the "Almirante." Her armament consists of ten 14-inch guns.

Of the five ships of the "Queen Elizabeth" class of 27,500 tons, mounting eight 15-inch guns and steaming at 25 knots an hour, two, "Queen Elizabeth" and "Warspite" were about completed at the opening of the war and three others, the "Valiant," "Barham," and "Malaya," were put in commission in 1915.

In 1913 and 1914, the five ships of the "Royal Sovereign" class were laid down and these ships were completed during the war. They are about 2,000 tons less in displacement than the "Queen Elizabeth" class and their speed is 21.5 to 22 knots. They mount the same battery of eight 15-inch guns.

Contrary to the general belief, Great Britain did not build many new battle-cruisers during hostilities. As a matter of fact, only two, the "Repulse" and "Renown," were completed and joined the the Grand Fleet. They are the longest and largest warships afloat, with an overall length of between 800 and 850 feet, a displacement of 33,000 tons and a sea speed of 33 knots. They mount six 15-inch guns, four forward and two aft and a battery of 15 torpedo defense guns mounted in five three-gun turrets.

Ships under construction or authorized, include three dreadnought battleships, probably of an improved and enlarged "Queen Elizabeth" type, and possibly four battle-cruisers of the "Renown" type. One of the battleships is about half completed and the keels of the other two have been laid, but comparatively little work done upon them. The condition of the four battle-cruisers is uncertain, although our own Navy Department credits Great Britain with having commenced work on all four. The British battleship fleet includes also 21 predreadnoughts and seven obsolete vessels.

STRENGTH OF NAVIES IN COMPLETED BATTLESHIPS AND BATTLE-CRUISERS AT SIGNING OF ARMISTICE

	Great Britain		United States		Japan		France		Italy	
Mr. Daniels' figures, as herewith given, are taken from a statement presented to the House Naval Affairs Committee on December 30th, 1918, and published in the New York Times of the following day.	Mr. Daniels' Figures	Correct Figures	Mr. Daniels' Figures	Correct Figures	*	Correct Figures	Mr. Daniels' Figures	Correct Figures	Mr. Daniels' Figures	Correct Figures
Battleships (dreadnoughts)......	61	33	16	16	.....	5	20	7	14	5
Battleships (predreadnoughts)....	.....	21	23	19	.....	12	.....	11	.....	9
Battleships (obsolete)..........	.....	7	.....	4	.....	.....	.....	3	.....	.....
Battle-cruisers (completed)......	9	9	.....	.....	.....	4	.....	.....	.....	.....

*Figures for Japan were not given in Mr. Daniels' table.

Table showing the correct figures of the comparative battleship strength of the leading naval powers

Geographical conditions under which the United States would require the most powerful fleet in existence

The United States Navy

Although on our entrance into the war the Navy Department concentrated all its efforts upon the construction

of anti-submarine craft, we made a great increase in the strength of our dreadnought fleet between 1914 and 1918 by the addition of seven of the largest and most powerful ships in existence. In 1916, we completed the "Oklahoma" and the "Nevada," 27,500 tons, mounting as their main battery ten 14-inch guns. The following year we completed the "Pennsylvania" and "Arizona" of 31,500 tons, each mounting twelve 14-inch guns. These were followed in 1918 by the "New Mexico" and "Mississippi," of 32,000 tons and twelve 14-inch guns. The "Idaho" was also practically completed at the close of the year and was ready to undergo her trials.

In addition to these vessels, we are building two more of the "New Mexico" class, namely the "California" and "Tennessee," which will be of about the same displacement but will mount eight of our very fine 50-caliber 16-inch naval guns. These vessels will be ready by the summer. So that by the time the peace treaty is signed, we shall be in possession of seven dreadnought battleships, all of which will be of about 32,000 tons displacement. A remarkable feature in these ships is the great thickness of armor which they carry, namely 14 inches on the belt and 18 inches on the turret, and their steaming radius is larger than

Battleship and Battle-Cruiser Strength of the Five Leading Navies

Great Britain

COMPLETED BATTLESHIPS (DREADNOUGHTS)

	Completed	Displacement	Guns	Speed
Royal Sovereign	1915	25,800	8-15-inch	21.5
Royal Oak	1915	25,800	8-15-inch	21.5
Resolution	1916	25,800	8-15-inch	21.5
Ramillies	1916	25,800	8-15-inch	21.5
Revenge	1916	25,800	8-15-inch	21.5
Queen Elizabeth	1914	27,500	8-15-inch	25
Warspite	1914	27,500	8-15-inch	25
Valiant	1915	27,500	8-15-inch	25
Barham	1915	27,500	8-15-inch	25
Malaya	1915	27,500	8-15-inch	25
Canada	1915	28,000	10-14-inch	23
Erin	1914	23,000	10-13.5-inch	21.5
Agincourt	1914	27,500	14-12-inch	22
Benbow	1914	25,000	10-13.5-inch	21.5
Emperor of India	1914	25,000	10-13.5-inch	21.5
Iron Duke	1914	25,000	10-13.5-inch	21.5
Marlborough	1914	25,000	10-13.5-inch	21.5
King George	1913	23,000	10-13.5-inch	21.5
Centurion	1913	23,000	10-13.5-inch	21.5
Ajax	1913	23,000	10-13.5-inch	21.5
Orion	1912	22,500	10-13.5-inch	21.5
Thunderer	1912	22,500	10-13.5-inch	21.5
Monarch	1912	22,500	10-13.5-inch	21.5
Conqueror	1912	22,500	10-13.5-inch	21.5
Colossus	1911	20,000	10-12-inch	21.5
Hercules	1911	20,000	10-12-inch	21.5
Neptune	1911	20,000	10-12-inch	21
St. Vincent	1910	19,300	10-12-inch	21
Collingwood	1910	19,300	10-12-inch	21
Bellerophon	1909	18,500	10-12-inch	21
Temeraire	1909	18,500	10-12-inch	21
Superb	1909	18,500	10-12-inch	21
Dreadnought	1905	18,000	10-12-inch	20.5

BATTLESHIPS (BUILDING OR AUTHORIZED)

	Work Begun	Displacement	Guns	Speed
Three of improved Elizabeth class	1917-1918			

BATTLESHIPS (PREDREADNOUGHTS)

	Completed	Displacement	Guns	Speed
Lord Nelson	1908	16.500	4-12-inch	18.5
Agamemnon	1907	16,500	10-9.2-inch	18.5
Commonwealth	1905	16,350		18.5
Dominion	1905	16,350		18.5
Hindustan	1905	16,350	4-12-inch	18.5
Zealandia	1905	16,350	4-9.2-inch	18.5
Hibernia	1906	16,350		18.5
Africa	1906	16,350		18.5
Swiftsure	1904	11,800	4-10-inch	19
Queen	1904	15,000	4-12-inch	18
Prince of Wales	1904	15,000	4-12-inch	18
Albemarle	1903	14,000	4-12-inch	19
Duncan	1903	14,000	4-12-inch	19
Exmouth	1903	14,000	4-12-inch	19
London	1902	15,000	4-12-inch	18
Venerable	1899	15,000	4-12-inch	18
Implacable	1898	15,000	4-12-inch	18
Canopus	1899	13,000	4-12-inch	18
Albion	1901	13,000	4-12-inch	18
Glory	1900	13,000	4-12-inch	18
Vengeance	1901	13,000	4-12-inch	18

BATTLESHIPS (OBSOLETE)

	Completed	Displacement	Guns	Speed
Magnificent	1895	14,900	4-12-inch	17.5
Hannibal	1897	14,900	4-12-inch	17.5
Prince George	1896	14,900	4-12-inch	17.5
Jupiter	1897	14,900	4-12-inch	17.5
Mars	1897	14,900	4-12-inch	17.5
Caesar	1897	14,900	4-12-inch	17.5
Illustrious	1897	14,900	4-12-inch	17.5

BATTLE-CRUISERS

	Completed	Displacement	Guns	Speed
Repulse	1916	33,000	6-15-inch	33
Renown	1916	33,000	6-15-inch	33
Tiger	1914	28,500	8-13.5-inch	30
Lion	1912	26,500	8-13.5-inch	28.5
Princess Royal	1912	26,500	8-13.5-inch	28.5
New Zealand	1912	18,000	8-12-inch	26.5
Australia	1913	19,250	8-12-inch	26.5
Inflexible	1908	17,250	8-12-inch	25.5
Indomitable	1908	17,250	8-12-inch	25.5
Battle-cruisers building—four				

United States

COMPLETED BATTLESHIPS (DREADNOUGHTS)

	Completed	Displacement	Guns	Speed
New Mexico	1918	32,000	12-14-inch	21.5
Idaho	1919	32,000	12-14-inch	21.5
Mississippi	1918	32,000	12-14-inch	21.5
Pennsylvania	1917	31,500	12-14-inch	21
Arizona	1917	31,500	12-14-inch	21
Oklahoma	1916	27,500	10-14-inch	20.5
Nevada	1916	27,500	10-14-inch	20.5
New York	1914	27,000	10-14-inch	21.5
Texas	1914	27,000	10-14-inch	21.5
Arkansas	1912	26,000	12-12-inch	21
Wyoming	1912	26,000	12-12-inch	21
Utah	1911	21,850	10-12-inch	21
Florida	1911	21,850	10-12-inch	21
Delaware	1910	20,000	10-12-inch	21
North Dakota	1910	20,000	10-12-inch	21
North Carolina	1910	17,000	8-12-inch	19.5
Michigan	1910	17,000	8-12-inch	19.5

PARTLY COMPLETED BATTLESHIPS (DREADNOUGHTS)

		Displacement	Guns	Speed
California	1919	32,000	12 14" ~~8-16~~-inch	21
Tennessee	1919	32,000	8-16-inch	21

BATTLESHIPS (PREDREADNOUGHTS)

	Completed	Displacement	Guns	Speed
Kansas	1907	16,000		18.5
Vermont	1907	16,000		18.5
Minnesota	1907	16,000	4-12-inch	18.5
New Hampshire	1908	16,000	8-8-inch	18.5
Louisiana	1906	16,000		18.5
Connecticut	1906	16,000		18.5
Virginia	1906	15,000		
New Jersey	1906	15,000		
Georgia	1906	15,000	4-12-inch 8-8-inch	19
Nebraska	1907	15,000		
Rhode Island	1906	15,000		
Ohio	1904	12,500	4-12-inch	18
Maine	1902	12,500	4-12-inch	18
Missouri	1903	12,500	4-12-inch	18
Alabama	1900	11,500	4-13-inch	17
Illinois	1901	11,500	4-13-inch	17
Wisconsin	1901	11,500	4-13-inch	17
Kearsage	1898	11,500		16
Kentucky	1898	11,500	4-13-inch 4-8-inch	16

BATTLESHIPS (OBSOLETE)

	Completed	Displacement	Guns	Speed
Iowa	1897	11,350	4-12-inch 8-8-inch	17
Indiana	1895	10,300		16
Massachusetts	1896	10,300	4-13-inch 8-8-inch	16
Oregon	1896	10,300		16

Italy

COMPLETED BATTLESHIPS (DREADNOUGHTS)

	Completed	Displacement	Guns	Speed
Caio Duilio	1915	22,700	13-12-inch	22
Andrea Doria	1915	22,700	13-12-inch	22
Conte di Cavour	1913	22,500	13-12-inch	22
Guilio Caesare	1914	22,500	13-12-inch	22
Dante Alighieri	1913	21,000	12-12-inch	23

PARTLY COMPLETED BATTLESHIPS (DREADNOUGHTS)

	Work Begun	Displacement	Guns	Speed
Colombo	Keels laid	31,000	8-15-inch	25
Colonna	but all	31,000	8-15-inch	25
Morosini	work stopped	31,000	8-15-inch	25
Caracciolo	during war	31,000	8-15-inch	25

BATTLESHIPS (PREDREADNOUGHTS)

	Completed	Displacement	Guns	Speed
Vit. Emanuele	1906	12,800		21
Regina Elena	1906	12,800	2-12-inch	21
Napoli	1907	12,800	12-8-inch	21
Roma	1909	12,800		21
San Giorgio	1910	10,500	4-10-inch	22.5
San Marco	1910	10,250	8-7.5-inch	22.5
Pisa	1909	10,600	4-10-inch 8-7.5-inch	22.5
St. Bon	1901	10,000	4-10-inch	18
Filiberto	1901	10,000	4-10-inch	18

France

COMPLETED BATTLESHIPS (DREADNOUGHTS)

	Completed	Displacement	Guns	Speed
Bretagne	1915	23,500	10-13.4-inch	20.5
Lorraine	1915	23,500	10-13.4-inch	20.5
Provence	1915	23,500	10-13.4-inch	20.5
Courbet	1913	23,500	12-12-inch	21
Jean Bart	1913	23,500	12-12-inch	21
Paris	1914	23,500	12-12-inch	21
France	1914	23,500	12-12-inch	21

PARTLY COMPLETED BATTLESHIPS (DREADNOUGHTS)

	Work Begun	Displacement	Guns	Speed
Normandie	Note: The keels	25,250	12-13.4-inch	21
Gascogne	of these ships	25,250	12-13.4-inch	21
Languedoc	laid and some	25,250	12-13.4-inch	21
Flandre	are plated up.	25,250	12-13.4-inch	21
Bearne	All work stopped during war.	25,250	12-13.4-inch	21

OLDER BATTLESHIPS (PREDREADNOUGHT TYPE)

	Completed	Displacement	Guns	Speed
Mirabeau	1911	18,500		19.5
Diderot	1911	18,500		19.5
Condorcet	1911	18,500	4-12-inch	19.5
Vergniaud	1911	18,500	12-9.4-inch	19.5
Voltaire	1911	18,500		19.5
Democratic	1906	14,900	4-12-inch	18
Justice	1906	14,900	10-7.6-inch	18
Verité	1906	14,900		18
Republique	1904	14,900	4-12-inch	18
Patrie	1905	14,900	4-12-inch	18
Henri IV	1901	9,000	2-10.8-inch	17.5

BATTLESHIPS (OBSOLETE)

	Completed	Displacement	Guns	Speed
Charlemagne	1897	11,300	4-12-inch	18
St. Louis	1898	11,300	4-12-inch	18
Carnot	1896	12,000	2-12-inch 2-10.8-inch	18

Japan

COMPLETED BATTLESHIPS (DREADNOUGHTS)

	Completed	Displacement	Guns	Speed
Fuso	1915	30,500	12-12-inch	22.5
Yamashiro	1916	30,500	12-12-inch	22.5
Ise	1918	31,250	12-12-inch	23
Hiuga	1918	31,250	12-12-inch	23
Settsu	1913	21,500	12-12-inch	20

PARTLY COMPLETED BATTLESHIPS

	Work Begun	Displacement	Guns	Speed
Negato (building)		32,500	10-15-inch	23.5

BATTLESHIPS (PREDREADNOUGHTS)

	Completed	Displacement	Guns	Speed
Aki	1911	20,000	4-12-inch	20
Satsuma	1910	19,500	12-10-inch	18.5
Kurama	1910	14,500	4-12-inch	22
Ibuki	1909	14,500	8-8-inch	22
Ikoma	1907	15,000	4-12-inch	21
Kashima	1906	16,000	4-12-inch	19
Katori	1906	16,000	4-10-inch	19
Iwami	1904	13,500	4-12-inch 6-8-inch	18
Mikasa	1902	15,200	4-12-inch	18
Hizen	1902	12,700	4-12-inch	18
Asahi	1901	15,200	4-12-inch	18
Shikishima	1900	15,200	4-12-inch	18

COMPLETED BATTLE-CRUISERS

	Completed	Displacement	Guns	Speed
Kongo	1913	27,500	8-14-inch	27.5
Hiyei	1914	27,500	8-14-inch	27.5
Haruna	1916	27,500	8-14-inch	27.5
Kirishima	1916	27,500	8-14-inch	27.5

that of any contemporary ships of which we know.

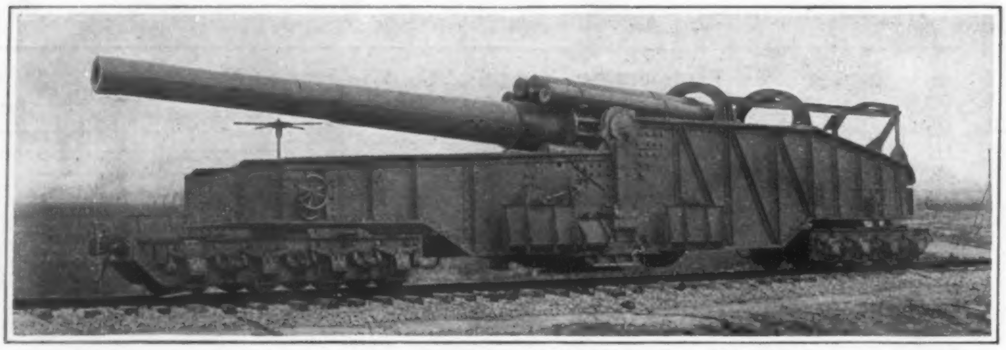
In the predreadnought class we have 19 ships, 11 of which carry in addition to the usual predreadnought battery of four 12-inch guns, a powerful intermediate battery of eight 8-inch guns; these are the six ships of

(Continued on page 64)

Guns for the Fighting Front

American Heavy Artillery Designed and Built for Our Armies in France

OUR experience in the late war proved that, for a nation as unprepared as we were, but possessed of a large measure of initiative and adaptability, it is easier to provide the personnel than the material. When the armistice was signed, about a year and a half after we entered the war, we had two million men in France and over a million in the United States, in uniform. The work of our men, considering the very limited training that it was possible to give them, was surprisingly and uniformly excellent and called forth the warm appreciation of the military leaders among our allies.



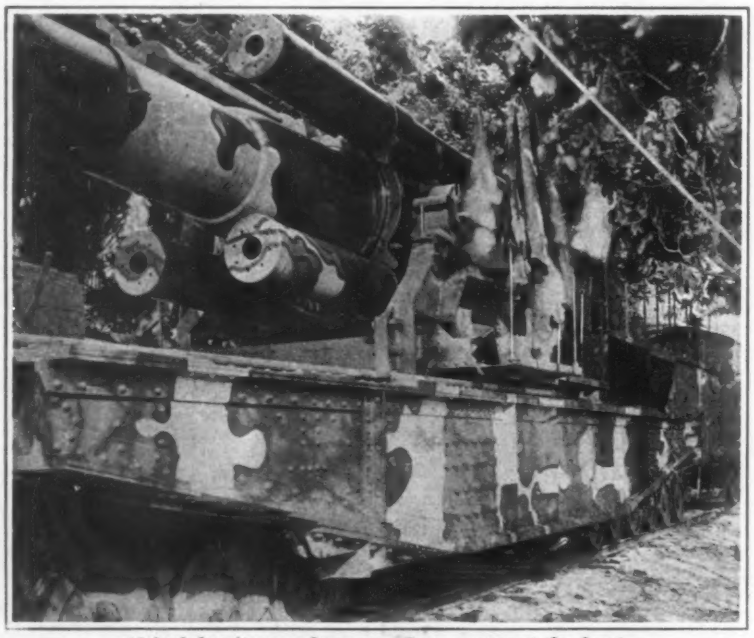
14-inch railway mount. Gun is wire wound. Shell 1,200 pounds. Velocity, 2,900 foot seconds Range 19 miles

In the broad field of engineering, also, we showed characteristic energy and resourcefulness, particularly in the provision of docks, yards, storage houses, and in the reconstruction of the main railway system which was allotted to us for the service of our army at the front.

Even in the matter of airplane service, although results were slow in coming, we were beginning to supply our fighting forces at a very rapidly increasing rate and with promise of a huge air force if the war had carried on into 1919.

But in the matter of artillery, and particularly the heavy artillery, we were up against a huge problem, which in the very nature of things, required time for its solution. Rifles can be produced in great numbers at comparatively short notice; machine guns, also, although requiring of course longer time, can be produced at a comparatively rapid rate, when once the plant is installed. When we come to field artillery, however, the task becomes more serious and the time element is the controlling factor. It is known that our army had to depend, in the first months of our active service, upon the French gun factories, which fortunately were in a position to give us the artillery we so imperatively needed.

But when it came to the question of immediately supplying heavy artillery, we were up against a situation—despite even our vast resources in raw materials, steel works, foundries, machine shops and skilled mechanics, to say nothing of a plentiful supply of capital—which required time for its full solution.



16-inch howitzer under camouflage screen at the front

These facts were well known to our army officers, war college, general staff; and such of our leading generals as were willing, in their patriotic desire to arouse the country to the seriousness of our lack of artillery, to risk the wrath of the politicians, sounded the warning for many a year previous to the war. We have only to instance the case of General Leonard Wood, who several years ago, as Chief of Staff, and persistently after the great conflagration broke out in Europe, warned us that we could not possibly extemporize artillery, either field or heavy, when war was upon us. That he should have paid the penalty for his candor and courage is an injustice that rankles deeply in the hearts of all patriotic and fair-minded Americans.

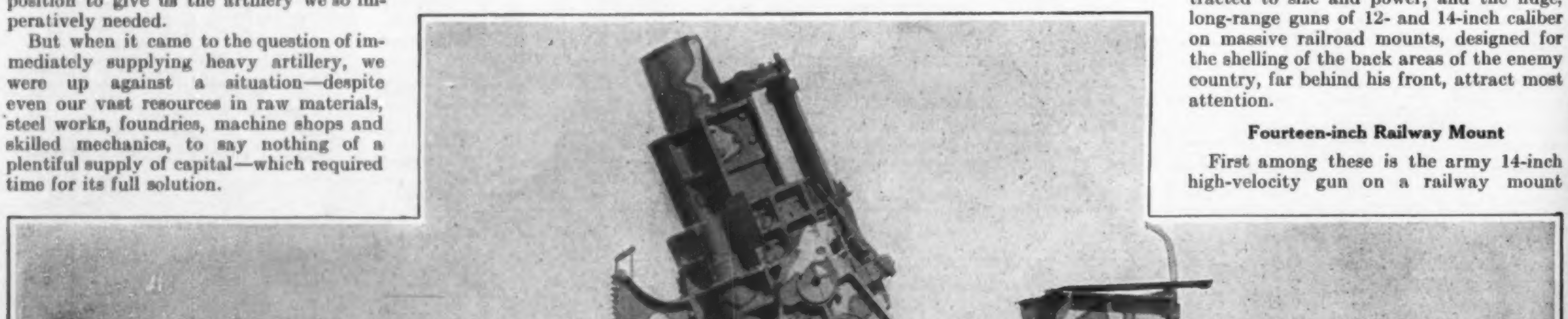
However, the moment war was declared, the army bent itself to its herculean task with its whole energy and our plans were laid upon a scale and prosecuted with a vigor which, if the war had run into another year, would have found our armies magnificently equipped. We had to begin work practically from the ground up; and, having at our disposal the accumulated experience of our allies during four years of war, our ordnance officers designed new models of all calibers and of every possible type which, when the armistice was signed, were already proving their high efficiency on the French front. By the courtesy of the War Department, the public is now being made acquainted with what has been done. Perhaps the best measure of the work undertaken by the Ordnance Department of the Army, is the fact that up to September 30th, 1917, contracts were issued amounting to $9,855,253,529.

The accompanying illustrations show some of the leading types of guns which have been designed and built.

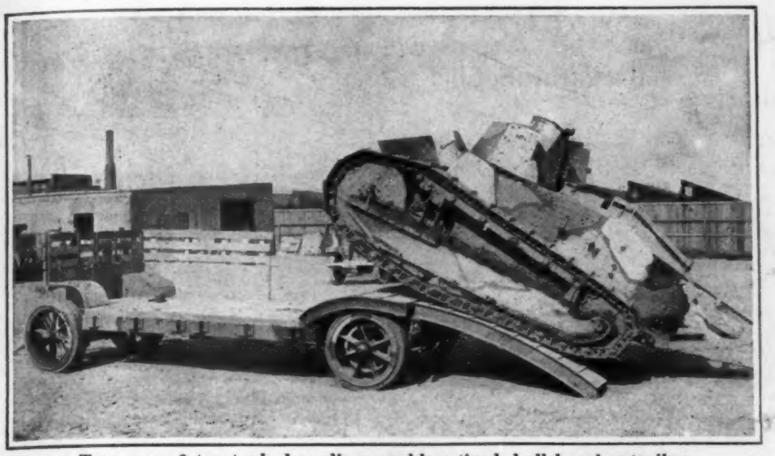
Naturally, the average citizen is attracted to size and power, and the huge, long-range guns of 12- and 14-inch caliber on massive railroad mounts, designed for the shelling of the back areas of the enemy country, far behind his front, attract most attention.

Fourteen-inch Railway Mount

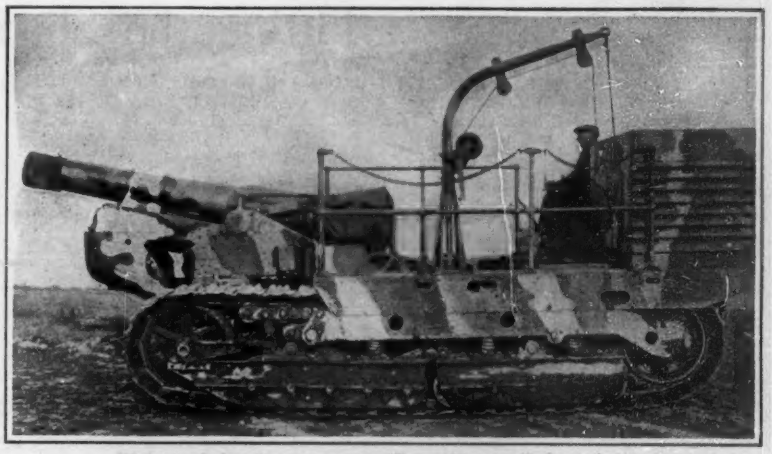
First among these is the army 14-inch high-velocity gun on a railway mount



12-inch mortar railway mount. Permits all-around fire. Maximum elevation, 65 degrees. Total weight, 177,000 pounds. Shell weighs 700 pounds Velocity, 1,500 foot seconds. For plunging fire against dugouts, cement shelters, etc.

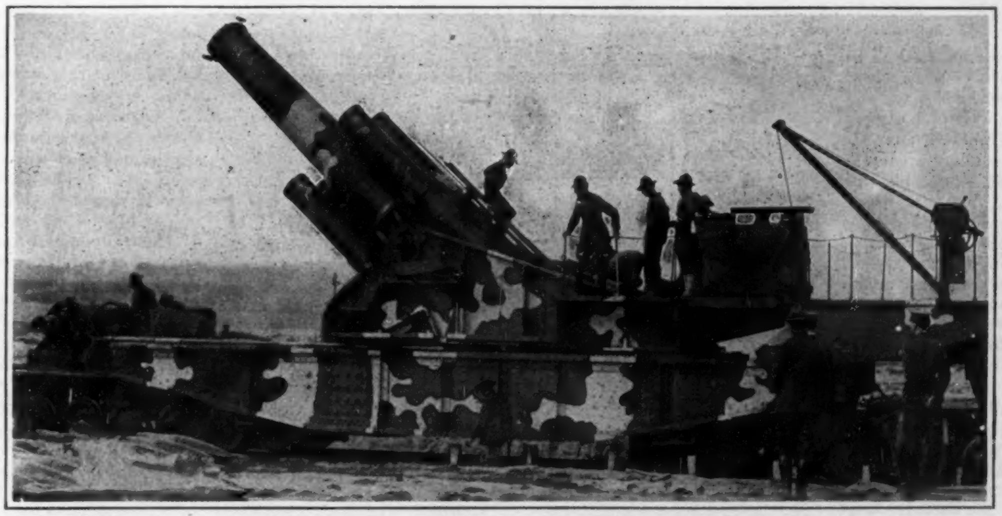


Two-man, 6-ton tank, boarding a rubber-tired, ball-bearing trailer for quick transportation



Eight-inch howitzer on caterpillar self-propelled carriage Speed, 1 to 4½ miles per hour

This mount was designed prior to the beginning of the war. It was intended primarily for the mobile seacoast defense of this country, and of course, was admirably adapted for service with our armies in France. Gun and cradle are mounted on a heavy, steel plate girder, the entire mount weighing about 250 tons. The gun is wire-wound, the caliber is 14 inches, and it is 47 feet in length. It fires a 1,200-pound projectile with 400 pounds of powder, with the high muzzle velocity of 2,900 feet per second. The range is about 19 miles. The recoil is partly absorbed by a hydraulic recoil brake, and the gun is returned to battery by counter-recoil springs. The gun is placed in the firing position on a cast-steel bed plate, which is adapted to give the mount a traverse of 360 degrees. About five hours are required to place this mount in position, using a well-trained crew. The rate of fire is one round every two minutes; and the mount has the advantage of being adapted for use against moving targets such as battleships, as well as for use against stationary targets on land.



Sixteen-inch railway-mount howitzer. Total weight of mount, 325,000 pounds. Can be fired on this mount up to 45° elevation. One of the most powerful howitzers known

Twelve-inch Sliding Railway Mount

Another type among big guns is the 12-inch sliding railway mount. This has no recoil mechanism, the recoil being absorbed by friction produced by sliding the mount on the special track which supports it. It is operated on a curved track and is trained on the objective by moving the mount backward or forward. The entire mount is 105 feet long, weighs approximately 600,000 pounds and is carried on four trucks of eight wheels each. It has been moved on railway tracks at the rate of 40 miles an hour. This 12-inch gun is 50 feet long; it fires a 700-pound projectile, with a muzzle velocity of 3,200 feet per second (the highest velocity for a big shell of which we know), and with a range of approximately 28 miles. The mount was built by the Ordnance Department, with the exception of the gun itself, in 85 days. After the track is laid and beam stringers placed, only about five minutes are required to move the mount into position and get it ready for firing, and it may be removed from the firing position in an equally short time.

Sixteen-inch Howitzer Railway Mount

The long-range high velocity guns above described are designed to attack the enemy's communications, railway depots, ammunition dumps, supply centers, etc., from 15 to 25 miles back of the fighting line. For the attack of the belt of country lying a few miles behind the front, and extending up to the front itself, use is made of howitzers, which fire their shells at a high angle of elevation, so that they may drop with a steep angle of descent, upon dugouts, concrete shelters, ammunition dumps, important cross-roads, and other vital elements in the enemy terrain. Conspicuous among these is our 16-inch howitzer, developed by the Ordnance Department, which is one of the most powerful howitzers known. It can be fired on its mount up to 45 degrees elevation, directly from the trucks, when resting on any standard gage track. The energy of recoil is taken care of partly in the recoil mechanism and partly by permitting the car to move backwards along the track on its own wheels. After firing the mount is returned to its original position by means of a gasoline-driven winch, mounted on the forward truck, which hauls in a cable anchored to the track ahead. The extreme range is about thirteen miles. The total weight of the mount is 325,000 pounds and its length overall is 58 feet 4 inches. In spite of the weight of the gun of over forty-five tons, it is so well balanced on its trunnions that it can be elevated to 65 degrees by one man in 40 seconds. The gun can be traversed five degrees to either side of center, or a total of 12 degrees can be secured. This is all that is required for range correction, and the direction is secured by moving the mount on a curved track. The entire mount was built within 75 days after the order was placed.

Twelve-inch Mortar Railway Mount

The 12-inch mortar railway mount is designed to permit all-around fire and may be elevated from minus

(Continued on page 62)

Five-ton artillery tractor. Built in four sizes: 2½, 5, 10 and 20 tons. Can haul guns through deep mud, shell craters, etc.

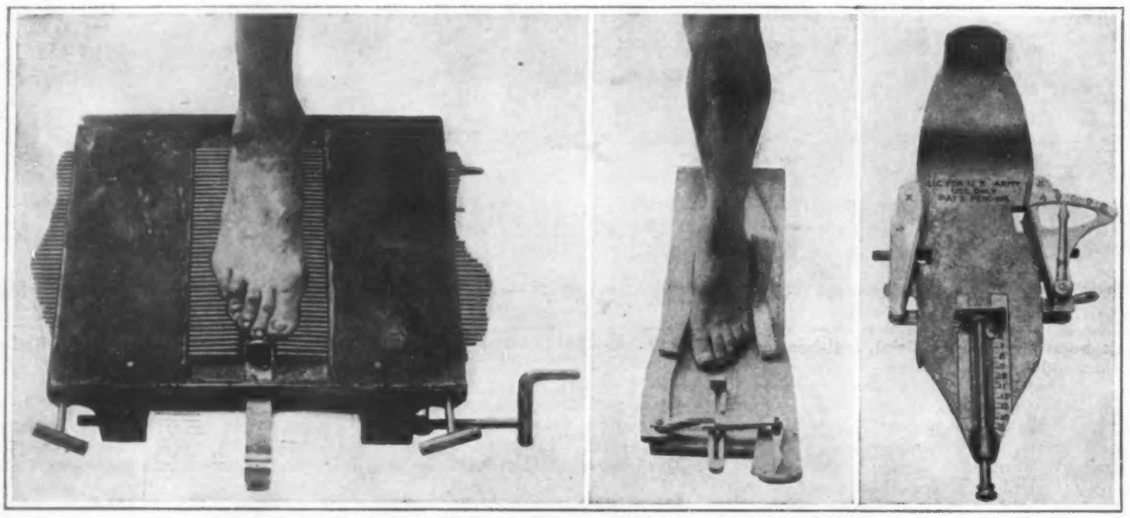
American "Baby" 3-ton tank. Speed twice that of a horse. Can haul guns Used against machine-gun nests

Fitting the Shoe to the Soldier

The Evolution of a Satisfactory System of Measuring the Soldier's Foot

THE proper fitting of soldiers' footwear, previously covered with normal thoroughness by government regulations, has been a matter of additional study, and has now led to the adoption by the War Department of new regulations authorizing a special system of foot-fitting, which it is the purpose of this article to describe.

Under normal conditions, a company commander could with little difficulty see that every member of his command was fitted with as nearly correct size of shoe as necessary. The few evils could be rectified within the company, and might be considered negligible. When the fact is considered that he must now depend at times upon men, unused to making such fits, to select from the 138 standard combination sizes the proper size for each man, and do this without loss of time, the need of a simple machine is evident. Furthermore, upon a compilation of the tariff of sizes used by the many organizations the Quartermaster Corps must depend also for its final tariff for ordering from manufacturers. The much needed machine, in addition to saving time, insures accuracy of fit to each soldier and a correct tariff for subsequent ordering.



Some phases in the evolution of a system for fitting shoes to our fighting men

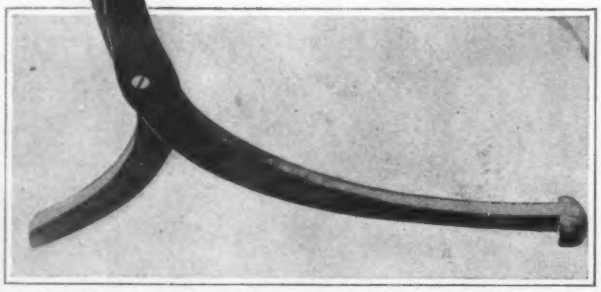
At the left: An iron device based on sliding iron blocks but discarded because it required use of a paper chart. *Center:* Automatic size and width indicator with foot inserted, developed by Mr. Bliss, at Charlestown Navy Yard and Quantico, Va. *At the right:* Final automatic foot-measuring device as officially adopted by the Army, Navy and Marine Corps in 1918

In a desire to make haste in supplying the recruits with their service shoes upon their arrival at the training camps, commissary officers and their assistants found it necessary under former conditions to allow the recruits, in many cases, to specify the sizes they should wear; and in some instances the new soldiers were permitted actually to pick out of stock the shoes in which they received their initial training. This careless practice is no longer allowed, because recruits from civil life do not know the sizes of army-last shoes which they should wear in preparing for and participating in actual warfare. Investigations made at a number of the concentration camps disclosed the following characteristics:

1. Ignorance of their correct foot-sizes, even in civilian shoes. 2. Ignorance of the difference between their size in civilian footwear and the corresponding size in army shoes. 3. Ignorance of the matter of making proper allowance for foot-expansion in the army shoe, produced by hard marching and the carrying of the soldier's fighting equipment. 4. Personal vanity, as shown in a desire to wear as small a size as possible.

And it is well known by now that soldiers must wear properly fitting shoes. The human foot is a fragile structure, containing 26 small bones of irregular shape. These small bones must be kept in their proper form and place to ensure efficient locomotion. Again, foot troubles generally lead to leg troubles, and a soldier who is impaired in his locomotion is no longer a good soldier. Hence the importance of properly fitting shoes is a paramount consideration in any efficient army.

It has remained for Mr. Elmer Jared Bliss, the president of a leading shoe company of Boston, Mass., to evolve a satisfactory army shoe fitting system. His principal aim in devising his system was to eliminate, so far as possible, the likelihood of mistakes being made in selecting shoe-sizes for the soldiers. It was believed that having got each new soldier right on the spot at the time of his entrance into the Army, and having disabused him of the idea that he himself was to exercise any jurisdiction over the selection of the size of his service shoes, the new system of fitting would have opportunity to operate so accurately that there could and would be no possible question about the soldiers being given the right sizes of shoes.



Length detector used to obtain size of shoes when markings are defaced, developed by Reclamation Department overseas

It was also necessary to create a system that would correctly provide for the 138 different combinations of sizes and widths required by the complete size-range of enlisted men—and yet be simple enough in details so that it would be easily understandable and usable by army officers and their subordinates who would conduct the measuring and fitting.

Kit or carrying case containing the foot-measuring and shoe-fitting devices, testing gage, and spare parts

The devices employed in Mr. Bliss's shoe-fitting system are two in number—a single machine, somewhat larger than the bottom of an adult human foot, which is the foot-measuring device, and a set of thin metal blades, each fitted with a metal knob on one end, which is the shoe-fitting device. The larger or measuring machine translates the foot length and width into the shoe length and width. The set of blades composing the shoe-fitting device is employed to prove the accuracy of the size as disclosed by measuring the soldier's feet in the larger machine.

The measuring machine is constructed for the great army of average feet—that is, feet that present no marked abnormalities. The elevation of the heel portion is of scientifically correct height for positioning the human heel when the foot is measured for the army shoe. The angle at which the side wings are set was determined from a composite of the angles of the inner soles and lasts of all the various sizes of the army shoe in the army size-range. The adjustment of the mechanism governing the operation of the pointer on the width-scale by the spreading action of the side wings, was also worked out upon a scientific basis.

The procedure of measuring is as follows:

The measurer requires the soldier to remove his old shoes, put on his army pack, hold his rifle, then set his stockinged foot onto the base of the foot-measuring machine, with the heel back snugly against the curved block at the back. It is essential that the foot be in the center line of the machine; that is, the imaginary line through the center of the foot from heel to toe should be over a similar line on the bottom of the machine.

The measurer then releases the wings at the sides and allows them to press in against the sides of the soldier's foot. He also slides the plunger, at the front of the machine, along until its flat end rests lightly against the end of the soldier's foot.

Then the soldier, keeping his balance by holding onto some sort of brace above, rises twice or three times on the ball of his foot. This act of rising closely duplicates the act of walking; and, since the soldier is carrying his regulation service load, the weight thus put into the spread of the foot when elevated upon the ball is the weight he will be carrying when he is actually wearing his shoes. In rising, he will lift his heel only about half an inch off the device.

The resulting spread of his foot, forward as well as sidewise, thrusts the sliding plunger forward so that its little marker-point automatically registers the correct shoe length; and the two side wings are thrust apart so as to cause the arm-pointer on the lettered scale to record automatically the correct shoe width as A, B, C, etc.

In his act of rising several times onto the ball of his foot, the soldier's foot causes the side-scale pointer to waver back and forth. The measurer observes this closely, and takes the middle mark, between the extreme points touched by the pointer, as the correct width.

Now having determined the size of shoes for the soldier to try on, the measurer proceeds on the second part of the fitting operation, which is to prove the correctness of

(Continued on page 63)

A Stretching Wheel for Red Cross Workers

EVERY Red Cross worker knows how much time and labor are required to fold gauze before cutting it into the required sizes. Unwinding the bolts and spreading layer upon layer on the long tables and getting all the layers smooth and even, is a task dreaded among the headquarters workers.

To lighten this work and make it comparatively easy, a Cincinnati man hit upon the Red Cross stretching wheel shown in the accompanying illustration. It is 7 feet in diameter and two women can stretch as much gauze with it in one hour as a dozen women can do in a day by the old hand-stretching method. One woman turns the wheel while the other keeps the gauze winding evenly and smoothly upon the big wheel. When the required number of layers are wound upon the wheel, they are cut through and taken off the wheel.

Other Red Cross workers are hereby requested to "steal" the idea and make wheels like it.

A Cincinnati man invented this stretching wheel for simplifying Red Cross work

The Current Supplement

THE study of the wonders and the mysteries of our earth offers endless attractions to the student and the scientist, and many of its problems are of the utmost economic value. One of these problems that has not been definitely solved relates to *The Age of the Earth*, and the paper having this title which appears in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2246, for January 18th, will be found of more than ordinary interest to the general reader. The task of maintaining an army in the field is infinite in its ramifications, and on its success depends the results of the contest, fully as much as on the actual fighting, and even more so, as without adequate supplies no army could exist. *Water for an Army*, with accompanying photographs, tells of one of the ever present problems confronting those behind the fighting lines, which is far reaching in its effects. The final instalment of the papers on *The Macoa Indians of Venezuela*, with a large number of unusually interesting photographs appears in this issue. *The 34 Supermagic Square* deals with a curious mathematical recreation of ancient origin, and is accompanied by many examples. The paper on *Molecular Orientations in Physics and Crystallography* is concluded in this issue. Other articles of interest include *Plant Growth and Reproduction; Atlantic Flight; The Raleigh Tercentenary; Some Peculiar Thermoelectric Effects; Sphagnum Moss* and *Wonderful Exhibition of Old French Silks.*

A Model Hospital on Wheels

FOR the rapid and proper transportation of our wounded in France, there have been built in England a number of hospital trains. To be more specific, the hospital trains have been built at the works of the Great Central Railroad of England at Dukinfield, and it is perhaps safe to say that these trains are the last word in the transportation of wounded.

The accompanying illustrations give some idea of the ward car of the American hospital train, which is fitted with every modern appliance for the comfort of the wounded men during long journeys. Each train carries a large Red Cross and the letters U. S., as well as the train number. There are accommodations for both lying-down and sitting-up cases, as illustrated. The train also includes a kitchen car and a coach for attendants.

With its beds raised, the ward car can be quickly and thoroughly cleaned

New Way to Make Castings of Non-Ferrous Alloys

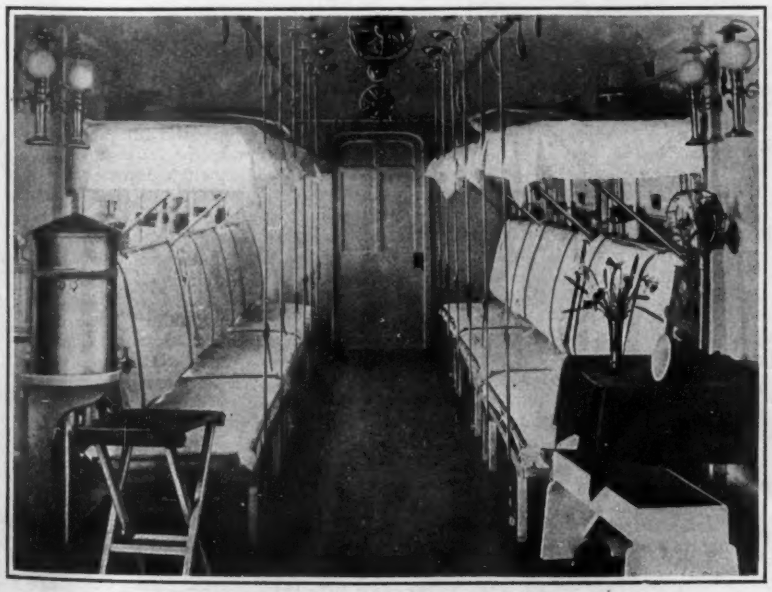
A PROCESS for forming castings of certain non-ferrous alloy, which is claimed to bestow unusual properties on the metal, is announced by a New York engineering company. Direct comparison is made between this and the usual method of casting such mixtures in sand. Parts made by this process are said to possess greater tensile strength, increased density and to be freer from blow holes. Their crystalline structure is said to be finer and the machining qualities superior.

The new process consists in pouring the molten alloys into metal molds and forming or congealing them under pressure. They are really die castings formed under high pressure. The inventor claims that the process gives absolute control of the desired physical properties and the machining qualities. A very large number of fuse bodies for shrapnel have already been made by this process. The composition of these is 80 per cent aluminum and 20 per cent zinc.

It is claimed that almost any grade of non-ferrous alloy can be handled by this process, the casting being made in a specially constructed automatic machine by which a large number can be produced in a day. Besides a 90-10 aluminum-copper alloy, there has been made one of 60 per cent copper and 40 per cent zinc with a trace of lead, having a tensile strength of 49,500 pounds per square inch and an elastic limit of 29,750 pounds per square inch with an elongation of 45.5 per cent in two inches. Another alloy of 86.5 per cent aluminum 12 per cent zinc and 1.5 copper is reported to have a tensile strength of 42,700 pounds per square inch and an elastic limit of 29,400 pounds per square inch with a definite elongation of seven per cent in two inches.

An interesting feature of this process is the possibility of making an alloy of aluminum, copper and iron which has a low coefficient of expansion. Success is said to consist in a special secret method of introducing the iron into the mixture. The ordinary piston made of aluminum and copper is said to have too great a coefficient of expansion but the introduction of the iron is regarded as making it possible to produce very large aluminum pistons as part of the essential equipment of high-power aircraft engines.

One of the many advantages claimed for this process is that important parts of aircraft motors can be made of great strength and lightness. In the case of pistons, the strength can be put into the head and the bosses where it is needed and they can be machined down to lighter weight and still possess unusual strength. The process has been patented in the United States, and in Great Britain, Japan and other foreign countries.



A ward car prepared for both lying-down and sitting-up cases

For the handling of lying-down cases, all the beds of the ward car are prepared

The Service of the Chemist

A Department Devoted to Progress in the Field of Applied Chemistry

Conducted by H. E. HOWE, Chemical Engineer

Federal Aid for Research

FROM a preliminary consideration it would seem possible to defend the general proposition that our agricultural interests have derived more from research than our other industries. This is not because our farmers are more appreciative of research than our manufacturers, but because some fifty years ago our agricultural experiment stations were established and through federal aid, intensive work was undertaken along lines which would doubtless have remained untouched for many years had the investigations been left for those most interested in the results. Our farmers are not alone in this attitude for it might be shown that in litigation or threatened law suits much of our brilliant industrial research has had its inception. True, agriculture, in common with other enterprises, profits from most of what is done in the manufacturer's laboratory, but, likewise, the factory gains when agriculture advances and this is simply further proof, if it were needed, of our interdependence in our complex civilization.

While the agricultural experiment stations have not always been managed to suit every one and some may even consider many of them failures, some of the results have been of the greatest value. Consider what has been accomplished in improving strains of corn, oats and wheat and what has been proven with reference to seed selections, germination tests and the breeding of corn, for example, to increase its feeding value. At another point work has been concentrated on questions of animal husbandry, the development of better stock and the study of feeding problems so that we may produce the maximum food with the minimum raw materials. Further the problem of what an animal does with its food has been studied with the result that more is known concerning its economical feeding and the point at which further food means a substitution of water for the fat previously stored and then "the critter eats his head off." Much of the stability of our dairy industry is directly due to agricultural college and experimental station work, no small part of which has been the invention of simple, dependable testing devices. Then there is that research which led to an increase in the average number of marketable tobacco leaves per plant equivalent to about 200 per cent increase in yield with the same amount of land and labor. Walnut trees that grow as rapidly as poplars and poplars which attain a height of 10 feet in 14 months are other examples of what can be done in agricultural research.

The dumping of cotton seed into the rivers of the South created such a nuisance that laws were enacted to stop the practice. On the basis of 1917 and 1918 prices the application of research to this waste problem added nearly $40 to the value of each of the 11,500,000 bales of cotton grown.

Crickets ate the binder twine used in tieing the sheaves causing considerable loss in the wheat fields after the grain had been put in shock until chemistry showed how to make binder twine unattractive. It was not enough to make it poisonous for there were crickets left over to cut other twine. It had to be made repellent.

These will serve as examples of the influence of law and necessity in instigating research. To interest the average man in research that strikes out to find something is a much more difficult task. The war has been a great educator in this direction and well qualified research men are in greater demand now than at any other time. Three hundred and fifty-five American manufacturing concerns maintain their own research laboratories and many more employ the facilities of commercial laboratories, consultants and educational institutions. The total is but a fraction of the number which should take full advantage of what modern science offers and the layman has yet really to appreciate research. Hence, the proposal now to establish engineering research stations throughout the country, one in each state, or to appropriate money for each state to be expended in the support of research of importance to science and industry carried on in whichever educational institution might show itself best suited to undertake the specific problem.

It is now proposed to grant $15,000 to each state the first year, $20,000 the next, $25,000 the third, and $30,000 the fourth and subsequent years. The details of administration are not decided, but the indications are that an impartial committee in each state will be made responsible, seeing to it that no money is spent without an adequate return in productive work, and that no favoritism is shown in the assignment of problems. A central organization in Washington will correlate the work, advise and suggest problems of national importance, but shall not be directive or administrative in its functions. It may be found advisable to change the secretary of this central body annually, appointing the assistant to be secretary, thus securing continuity without the danger of stagnation. Such a post, properly paid, would be attractive to many scientists qualified to perform the work since it would offer many advantages not to be measured by monetary standards.

This plan, known officially as the Smith-Howard Bill (S. 3805 and H. R. 9686), is undergoing modification and improvement, many of our country's best minds being active on the questions involved. The National Research Council, the American Chemical Society, the foremost educators and engineers sanction the principle and mean to see a workable plan prepared for the approval of Congress. The competition between the educational institutions in each state for this federal aid, the granting of which, will in itself, be recognition of the high quality of work being done there, constitutes one of the sure benefits. Facilities will be provided with which those qualified may work under the best conditions as regards equipment and assistance. A larger number of our young people will acquire the scientific method of attack and become so acquainted with materials that industry will be benefited when they go out to it, not to mention the advances which may be expected from the laboratory work. In some instances research can be directed from present interesting but less practical lines to those substances of more urgent importance and equal interest.

That federal aid to research can be given in a practical, efficient manner and be made profitable has been demonstrated by the agricultural experimental stations. We should do better, in view of our experience, with the new plan. The war has conclusively demonstrated the value of scientific research and all countries are organizing to pursue it diligently. The opportunity is offered for the people at large, our educational institutions and our industries to become really interested in research and to profit by its achievements in the various specific fields.

Some Phases of Reconstruction

CHEMISTS generally realize that the post-war problems are more complex than those imposed by war when questions of low costs and competition are not so important. There has been much looking ahead and one of the first instances of concerted action was a recent meeting of the Council of the American Chemical Society. The question of what to do with our excess acid production, our gas manufacturing plants and the munition factories could not be considered a part of the program, the discussion being on subjects of general policy.

The Germans have been called the brick layers, *not* the architects, of science and among the tedious pieces of work performed has been the compilation of chemical data and statistics. "Beilstein" had become an almost holy word in organic chemistry because in no other place could so much fundamental information concerning organic chemicals be found as in this excellent example of brick laying. And yet Beilstein is not wholly satisfactory. The work of non-Germans is slighted in the statistics. It is 20 years old and incomplete. Arrangements are now under way for English speaking chemists to combine on the truly gigantic task of preparing a compendium of chemical literature in English to be complete in each of the many sub-divisions of modern chemistry. Steps are also to be taken to make the various publications of the American Chemical Society and notably "Abstracts" the very best of their kind offering advantages which will insure the publication of our American work in them rather than in foreign journals as heretofore.

The matter of tariff on importations of chemicals and scientific apparatus has been of interest to many chemists since educational institutions have always been entitled to duty-free importation. It would, quite obviously, be inconsistent for chemists to advocate protection for dyes and other American-made chemicals and yet ask for duty-free advantages in matters concerning their own requirements even in schools, although the difference in costs meant $20,000 increase in laboratory expenses in one university. The abolition of the duty-free privilege was recommended.

The need for a closer coöperation between universities and industries is apparent. If the industries are to continue to benefit by the work done in the schools and are to have men properly prepared for their service something must be done to make the teaching profession more attractive financially. One of our greatest technical schools, at the present moment, finds it almost impossible to maintain an adequate staff because of the lack of money, and a professor can not pay his bills with sentiment. Industry must become more directly interested in education if we are to maintain our world-wide advantages. The society appreciates the situation and a number of sub-committees are to be appointed to work with the main committee on this perplexing problem.

Chemists enjoy the unique position of being really interested in all industry either because they contribute some manufactured article or have some part in the development and maintenence work. They realize the necessity of an active, sustained export trade and urge any measure calculated to improve it. This is ample reason for urging the adoption of the metric system of weights and measures in the United States as rapidly as possible. Many successful American exporters are using the metric system now, having found it a handicap to adhere to the English system in foreign commerce. It is doubtful whether the metric system will come into universal use in our country within a considerable period of years, due to alleged complications in land measurements although the civil engineer already uses tenths of a foot, but every one owes it to himself to become familiar with it.

Closely allied with reconstruction is the work looking to guaranteed peace for the future. It seems important, therefore, to continue some of the research carried on so successfully by the Chemical Warfare Service and to coördinate research in the War and Navy departments. This is also the time to record in full the details of what has been done on war problems and publish anything not of military importance for much of this research has both a scientific and industrial interest. The best talent in our country has been in coöperation during the emergency and it would be a distinct loss not to have all records clear before the first chemical military unit in history, and recognized as such, is allowed to disband.

The war served to emphasize the desirability of more extensive American research in the field of drugs and medicines and to that end careful consideration is being given the suggestion that an Institute for Coöperative Research be formed. In such an institute chemists, biologists and manufacturers would work together on the nearly innumerable problems which are of practical as well as scientific importance.

The American Chemical Society has only begun its study of reconstruction on the committee plan and its next meeting is expected to yield valuable results.

Scientific Patents

WHEREVER research is proceeding in sustained fashion much that is patentable may be expected. Because of the circumstances under which scientists serve in the Government's employ the practice of assigning patents to the people has been followed since early in the eighties. This plan has the fundamental weakness that unless some protection can be secured no one is going to see any process through its development stage and consequently very little has ever come of those inventions donated to the public in their infancy.

Two alternative plans are now under consideration. One of these provides for a non-exclusive free license to the Government for its own use and for the use of its licensees, all other rights remaining with the patentee including foreign rights as at present. There are some minor details with respect to payment of fees, etc. The other suggestion is based on a plan that seems to have been satisfactory in the case of the Cottrell patents, which were really assigned to the Government through the Smithsonian Institution, but with a license system the fees from which have paid for the development work and will finance further research in future.

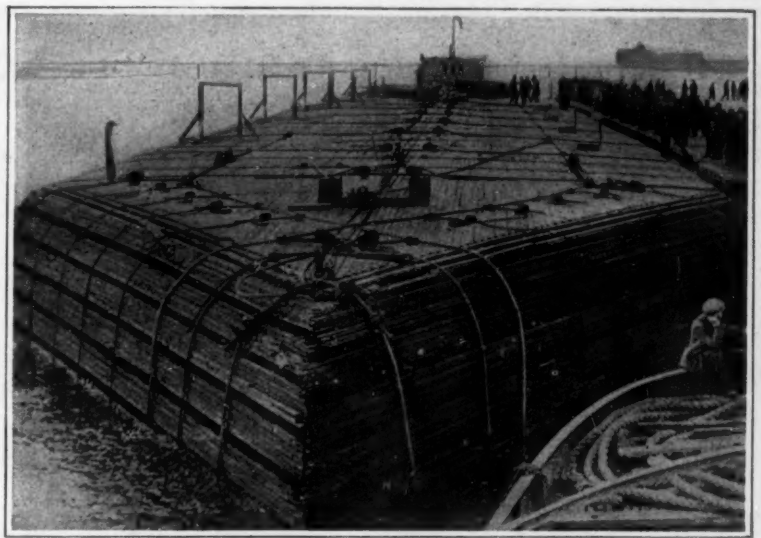
It is proposed by this second plan to have the licensing of any patents assigned to the people placed with one of the trade boards. This board would use the fees for development work and for the reward of the patentee while at the same time the Government may benefit from the patents without charge.

An Enormous Log Raft for Overseas Transportation

WHILE log rafts are by no means new, inasmuch as they are quite common in this and other countries, the huge raft recently constructed at Haparanda, Sweden, and used to ship a large number of logs to Copenhagen, Denmark, is worthy of passing mention.

The great raft, which is shown in the accompanying illustration as it appeared anchored at a wharf in the harbor of Copenhagen, measures 387 feet long, 55½ feet wide, 10 feet above the water line and 16½ feet below.

The raft took six months to build and contains as much wood as four big steamers. It is held together by an ingenious system of steel cables and wires, and is capable of carrying a large amount of material. The crew consists of seven men.



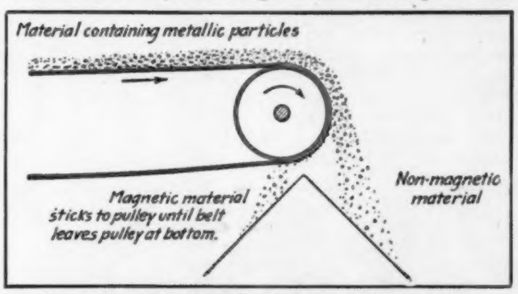
Huge raft made of logs held by steel cables, which made the trip from Haparanda, Sweden, to Copenhagen, Denmark

Magnetic Pulleys

MAGNETISM in some of its many applications is so commonplace that it no longer creates particular interest. Upon it the electric dynamo, the motor, the lifting magnet and many other familiar electric appliances depend for their operation. An out-of-the-ordinary application, however, and one that will be new to many readers is that presented by the magnetic separator pulley, as used in a greatly increasing list of industries.

These devices are useful wherever it is desired to remove continuously the magnetic content from non-magnetic bulk material. For example, they are successfully employed in separating pick heads, coupling pins and other metals from bulk goods passing to a crusher which would be damaged by the entrance of such material. They are used for a similar purpose at phosphate rock mines and quarries. In the production of sulfite fiber paper stock they are available for removing tram iron and steel from the wood chips before these are delivered to the sulfite tanks. They are also found valuable in the manufacture of cement, the production of gypsum and limestone, the making of terra-cotta clays, and doubly so in freeing grains, spices and tobacco from bits of iron and steel before grinding. Even in such an unpoetic place as the city disposal plant they are put to work in picking out tin cans, horseshoes, nails, etc., from the worthless material. Likewise the high cost of metals has made the saving of metal turnings and the separation of iron and steel from brass well worth while.

Another interesting application is found in the sugar industry, one in which it would seem that there would be no field for such equipment. The separator here is installed to remove from animal charcoal iron rust or iron oxide which is collected by it while passing through the ovens and being baked. This baking process is necessary to eliminate from the charcoal the impurities which it has absorbed from the sugar. The magnetic material is especially prevalent after the retort has been repaired. Under ordinary conditions the magnetic pulley is energized only part of the time, two weeks out of a month or so, this being sufficient to keep the iron oxide out of the bone charcoal so that trouble with iron coloring in the sugar is prevented.



How the magnetic pulley sorts out the sensitive from the non-sensitive

A word or two as to the general scheme of operation of the magnetic pulley separator may not be out of place. It is magnetized by passing direct current windings in the interior of the pulley. The current sets up a magnetic flux which passes through the belt as it turns about the pulley, thus attracting any iron or steel contained in the material which is carried on the belt. These pieces are then held in contact by the pulley until the belt leaves it on the under side. Here they are dropped, and collected in a box which is kept well separated from the shower of the other material leaving the belt by means of a barrier as shown in our drawing.

Direct current is required to energize the pulley, although of course the alternating variety will very likely be used to rotate the belt. Only a small amount of juice is necessary to keep the magnet working, the average for the sizes in greatest use being but a few amperes. Standard pulleys can therefore be connected to any 110- or 220-volt direct current system, although pulleys may be designed with coils suitable for operation on currents of 500 volts, or even more.

Data on Women's Work Wanted by Labor Department

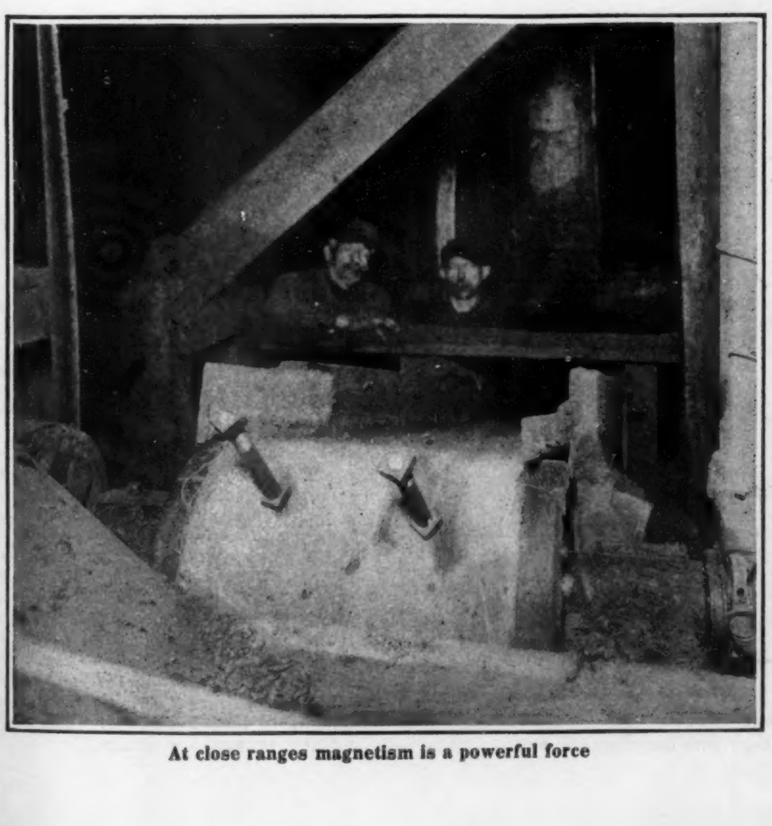
THE Woman in Industry Service of the United States Department of Labor is collecting and distributing information on such topics as the extent of employment of women during the war, the wide variety of their employment, the methods by which they have been successfully introduced into new occupations, and the safeguards with which it has been necessary to surround them in the interests of their health and efficiency.

Plans are being made to establish a pictorial record of the work women are doing, and the Woman in Industry Service is asking for the coöperation of the employers of the country in assembling these pictures. Illustrations are desired of the various processes on which women are working, particularly those in which women are substituting for men; mechanical adjustments installed to enable women to do work formerly impossible for them; safety devices that have been found necessary to protect women workers; and special arrangements and equipment that have been installed for the comfort of the workers.

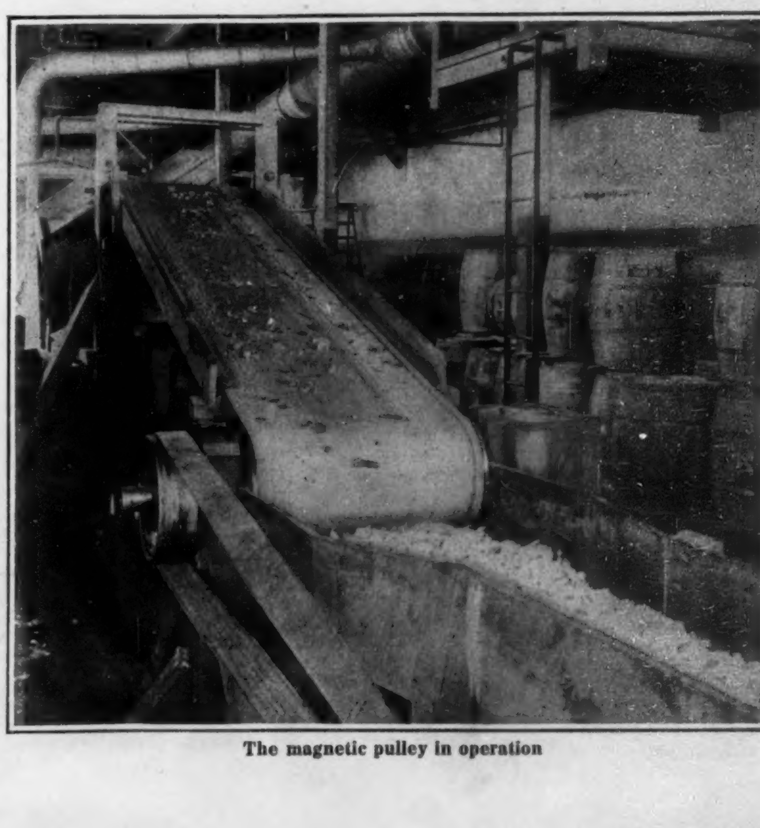
Manufacturers would be rendering valuable assistance if they would forward to the Women in Industry Service any pictures of this description that they have or are able to obtain. If any firm has recently improved the conditions under which its employees are working, pictures taken before and after the improvements were made would be particularly welcome.

These pictures will be used to form a permanent record of women's work. When the photographs are forwarded it will be appreciated if a statement is attached of the name of the process and any other particularly significant facts.

If the pictures are published the names of the firms will not be used without permission.



At close ranges magnetism is a powerful force



The magnetic pulley in operation

The Motor-Driven Commercial Vehicle

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

Wounded Canadian soldiers learning to operate farm tractors

Farm tractor built by a prominent Italian motor car company

Teaching Wounded Soldiers to Operate Tractors

THE problem of providing suitable occupation for wounded soldiers has occupied no little of the attention of manufacturers of farm tractors, as well as others. Canada, which has had the wounded soldier problem to deal with for some time, has opened a number of schools where the men are instructed in the handling of tractors, and it has been found that even artificial limbs are not necessarily a serious disadvantage in this line of work. Of course some of the men take to tractor driving more readily than others; but on the whole the idea has worked out very satisfactorily. The matter is all the more important because good work with a tractor calls for a good operator; a good tractor with a poor operator is capable of turning out highly unsatisfactory work.

There is an instruction base in Toronto, Canada, where a considerable number of soldiers have been made familiar with tractor driving. All the men there have received wounds that have made it impossible for them to resume their former occupations, and the tractor idea has therefore, a strong appeal to them. The man shown driving in the photograph has an artificial leg, notwithstanding which, he did excellent work.

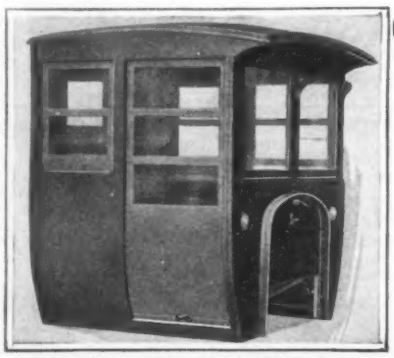
Protection for the Truck Driver

AS the commercial vehicle grows in importance as a means of transportation the man who operates it quite naturally comes in for increased consideration. In winter weather he is likely to suffer a good deal without proper protection. Such protection is afforded by a cab that is supplied as part of the regular equipment of a truck that recently has been placed on the market by a firm whose attention has hitherto been confined to passenger cars. It is customary to sell trucks "in the chassis" all ready for the body, but with no body on the frame. In this instance the usual custom is followed, but the cab is added.

The cab is of very substantial construction and instead of providing only partial enclosure, it completely houses the driver's seat. In front there are large glass windows which can be opened when the weather is mild and at the sides, in place of doors and windows, there are heavy curtains that fit closely and snugly and are readily adjusted either to open up the cab or to let the driver get in and out, in the case of the door sections. Very large flexible panels give a good view in all directions. The seat is more than usually well upholstered and, altogether, the driver of one of these trucks will find himself a good deal more comfortably situated than most of his fellows. Side lamps are inset flush with the front. The front panel at the same time forms the dashboard of the truck and serves to support the rear end of the hood.

Engine Heats Its Fuel Three Times

THE very large percentage of kerosene found in the gasoline that is commonly supplied today has made it necessary for all manufacturers of gasoline engines to take measures to supply considerable heat in order properly to vaporize the heavy constituents of the fuel. One manufacturer of light motor trucks takes the precaution of heating the fuel three times in order to ensure its being thoroughly vaporized and to distribute the heating uniformly throughout the vapor.



A cab to protect the truck driver

The first heating is by means of the ordinary "stove" on the exhaust pipe, through which the air drawn through the carbureter is made to pass. Leaving the carbureter the air, together with the atomized gasoline which it has taken from the carbureter, enters a passage cored between the cylinders, this being kept hot, of course, as long as the engine runs. Lastly the gas impinges against a metal surface the other side of which is in direct contact with the hot exhaust gas —in fact, the surface is one of the walls of the exhaust manifold. The result of this arrangement is a clean engine, maximum power and a low fuel consumption.

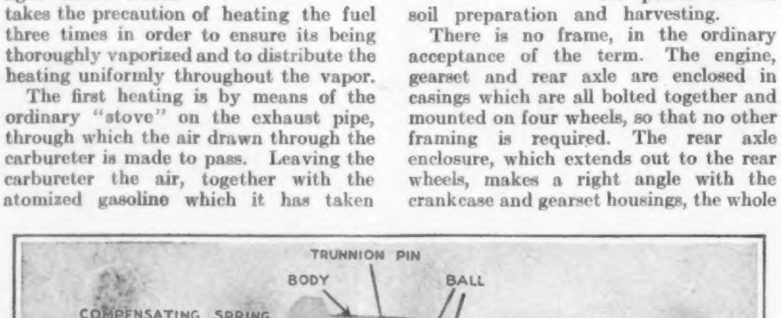
Italian Manufacturer Prepared for After-War Tractor Demand

A LARGE Italian firm which manufacturers not only automobiles, but trucks, motorboats, airplanes and numerous other automotive products, has designed a three-plow tractor that is intended to supply the needs of the average farmer for power for his soil preparation and harvesting.

There is no frame, in the ordinary acceptance of the term. The engine, gearset and rear axle are enclosed in casings which are all bolted together and mounted on four wheels, so that no other framing is required. The rear axle enclosure, which extends out to the rear wheels, makes a right angle with the crankcase and gearset housings, the whole forming a big T. Such a construction gives absolute rigidity and all the strength that could possibly be required.

The gearset allows choice of three speeds and is fitted throughout with ball bearings and final drive to the rear axle is through a worm gearing. A peculiar feature of the machine is that the worm shaft is extended through the housing at the rear and carries the pulley for the belt used in driving stationary machinery. As the pulley thus comes between the rear wheels means are provided for very quickly and easily removing one wheel, on the side toward the machine to be driven. A special permanently attached jack is used for raising the tractor and holding it up when doing belt work. The source of power is a four-cylinder block-cast engine that is practically identical with the engine used by the same firm in one of its 3½-ton trucks and has a bore of 100 mm. and a stroke of 180 mm.

The tractor weighs 2½ tons and has a maximum speed of 3.7 miles an hour and a speed on low gear of 1.2 miles an hour.



Phantom view of a universal joint with large bearing balls

Big Steel Balls in Universal Joint

A UNIVERSAL joint of unusually interesting construction is used in a 1½-ton truck that is making a good record for itself in service. In this joint there is a total absence of the usual flat bearing surfaces and cylindrical journals. Instead there are large hardened steel balls mounted on opposite ends of a trunnion pin at the end of the propeller shaft. The steel housing of the joint is made with two oppositely disposed grooves or races accurately formed for the balls to work in; they are elongated, however, so that the balls are allowed the longitudinal motion necessary to permit the joint to operate at an angle. The balls are free to turn on the trunnion pin, so that they are constantly shifting and presenting their entire surfaces for wear.

The lubricant tends to work to the points farthest from the center due to centrifugal force, which carries it into the ball races and puts it where it does the most good.

When two of these joints are used, one at each end of the propeller shaft, the usual rectangular or splined slip-joint is not required. The balls have sufficient longitudinal freedom in their grooves for the purpose. In each housing there is a helical spring, the forward spring tending to push the shaft backward, and the rear spring tending to push it forward. The shaft "floats" between the springs.


VALUE
NOT the price you pay, but the *years of service* you get, determines a motor truck's cost. Economy of operation and maintenance is the determining factor.
You might buy a motor truck at an extremely low price, yet pay dearly in the end. Inversely you might *invest* considerable money in a motor truck, yet pay little per ton mile or year of service.
There is no better indication of any article's actual worth than its "forced sale" price.
At a creditor's sale in Chicago, recently, 14 motor trucks were sold at auction. A Service Motor Truck 22 month's old brought $84\frac{3}{8}\%$ *of its original price. The others, used only 10 to 18 months, sold for about* one-third *of the first cost.*
From the investment standpoint, Service Motor Trucks are "gilt edge."
Consult the nearest Service Distributor, or send for catalog which gives full details of the five models and four sizes, from 1 to 5 tons.
SERVICE MOTOR TRUCK CO., WABASH, IND.
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93
Service
MOTOR TRUCKS

What Machinery Is Doing for the Walnut Industry

(Continued from page 51)

they are distributed across one end of a sieve which operates like an endless belt. This sieve conveys the nuts beneath a chute which extends down from the overhead motor-driven blower that operates the vacuum device. This arrangement exerts just enough suction to pick up all of the nuts which are below a certain weight, leaving the heavier nuts of grades one and two to pass to the end of the sieve and glide down a long chute to the packing shed.

The third machine invented by members of the association to convert the cull into a profitable by-product is the shell separator. This is used to handle the tailings of the mill. After the nuts are cracked and the girls have extracted from the shells all of the meats they can find there are usually small bits of meat left in some of the shells, and women who are either careless or new at the work frequently overlook choice pieces of meats and sometimes whole halves while working over a pile of cracked nuts.

The manager noted that there was considerable waste from that source, so he had a machine built to handle the tailings, and it has resulted in a saving of $50 worth of broken meats per day since it was put into operation. This device is built on the plan of a small threshing outfit, and yields a product material which, before the final sifting, runs about 80 per cent halves and broken pieces of nut meats and 20 per cent of shell particles.

The walnut grower used to average about 3 cents per pound for his culls, and was unable to separate the shriveled meats from the sound ones, so the value of his better grades was depreciated. Today he gets from 5 to 7 cents per pound for his culls, and the sound nuts sell proportionately higher because they are of standardized quality. In 1915 the association cracked and sorted nuts by hand and marketed 434,000 pounds. Last year it sold all the meats it could obtain, and this year it is marketing 1,500,000 pounds of culls alone by the by-product system.

Guns for the Fighting Front

(Continued from page 55)

five to plus 65 degrees, having a range of nine miles at the latter elevation. The total weight of this mount is 177,000 pounds, the gun weighing 29,000 pounds, carriage 57,300 and car 90,000. The projectile weighs 700 pounds and the powder charge 65 pounds, which gives a muzzle velocity of 1,500 feet per second. This mortar is not designed for long-range but for plunging fire at shorter ranges, where great penetration is desired. The shells, filled with high explosives, are very effective in destroying ammunition dumps, dugouts, cement shelters, quarries, etc. When it is necessary to bring this mortar nearer the enemy, provision has been made to replace the standard six-wheel trucks by narrow gage trucks making the carriage very mobile and effective.

Upon firing, the mortar moves to the rear about thirty inches, the energy of the recoil being partly absorbed by the resistance which the fluid in the recoil cylinders on the bottom of the cradle, offers to being forced past the pistons. A portion of this energy, sufficient to return the gun to its original position, is absorbed by compressing the air in the recuperator cylinder on top of the cradle. The return of the mortar is eased by buffers in the front of the recoil cylinders. Approximately 300 rounds have been fired from one of these 12-inch mortar railway mounts with no impairment of any of the working parts.

The guns above described are all adapted to transportation on railway tracks and in addition to those illustrated, mention should be made of a very effective eight-inch railroad mount, model 1918, with its own ammunition car, which at a maximum elevation of 42 degrees fires a 200-pound projectile to a range of 20,000 yards. This mount permits of an all-around fire without changing the position of the mount on the tracks.

Eight-inch Howitzer on Self-Propelled Caterpillar Mount

In addition to the above artillery, the Ordnance Department developed some mobile heavy artillery for transportation over the highways, and if need be, across the fields, quite independently of the highways. A very fine piece is the eight-inch howitzer mounted on a self-propelled carriage of the caterpillar type, so designed as to make the entire unit self-contained and adapted for quick mobility. The self-propelled carriage is designed along the same general lines as the artillery tractors which played such a prominent part in the field operations of the Allied armies. It is propelled by a four-cylinder, heavy-duty, tractor motor developing about 75 horse-power at 850 revolutions per minute. The design of this unit is such as to permit a few degrees traverse of the howitzer to the right and left, as well as the full elevation of the piece. A small supply of ammunition can be carried on the platform of the gun mount, with a reserve carried on cargo-carrying "caterpillar" tractors, sufficient to serve the howitzer or battery of howitzers. This howitzer mount is capable of speeds ranging from about one to four and a half miles per hour, and is so designed as to require less than one minute to put it in firing position from road travel. The total weight of the vehicle is approximately twenty-five tons, though, on account of the large track area, the concentrated pressure per square inch is but slightly greater than that exerted by an ordinary horse. Sufficient fuel and oil are carried to permit the vehicle to travel about ten hours under full load, without replacing the supply.

The new ordnance includes, also, an eight-inch railway mount, with ammunition car: shell 200 pounds; range 20,000 yards; all-round fire.

During a test the tractor gun climbed a 45-degrees ravine wall and developed a speed of four miles per hour on level ground, demolishing trees and shrubbery just as do the monster tanks.

Five-ton Artillery Tractor

The five-ton artillery tractor, developed and built in large quantities by the Ordnance Department, has put the horse out of business so far as pulling guns is concerned. Deep mud, shell craters, sand or logs cannot detain artillery when pulled by this type of tractor. The Ordnance Department has produced them in four sizes; namely 2½-, 5-, 10- and 20-ton capacity. Automobile engineers and automobile factories with large production facilities made these tractors possible.

"Dreadnought" and "Baby" Tanks

Tanks played the most decisive part in the later phases of the war, and the Ordnance Department, on a joint production schedule with England, brought out a 35-ton tank which, in its general appearance, is similar to the first tanks used by the British on the Somme. This design, which is driven by an American 12-cylinder Liberty motor, carries 12 men, four machine guns and two six-pounders. Wireless outfit, by which communication is always had with headquarters, is a part of its equipment.

"Machine Gun Cavalry" is the name that should properly have been assigned to the American "Baby" or three-ton tanks, developed by the Engineering Division of the Ordnance Department. Capable of a speed double that of a horse and with one man firing at a rate in excess of the firing of ten men with rifles, this type of tank saves the work and lives of many thousand soldiers. It advances against machine gun fire, and can pull guns as well as carry fighters.

Six-ton Tank and Trailer

This American, two-man, six-ton tank closely resembles the famous French

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Renault, the terror of the German machine gun nests. For quick transportation to the places of activity the ordnance engineers provided a rubber-tired, ball-bearing trailer, an American artillery tractor being provided to haul the entire outfit over any kind of roadway.

9.2-inch Howitzer and 11-inch Trench Mortar

In addition to the artillery above enumerated, we possess five 9.2-inch mobile howitzers of the siege type, built from a British design; and it is now recommended that a total of 20 be completed. This piece fires a 290-pound shell with a maximum range of about 10,000 yards, and for traveling it divides into three loads of about 14,000 pounds each, including the transporting vehicle. We have also gotten out a design for a 11-inch trench mortar with a maximum range of 4,500 yards.

The unexpectedly early termination of the war leaves the country in an excellent condition as regards its capacity for the construction of all sizes of artillery in the event of a future war. Many of the plants will, of course, be dismantled; but the great Government establishments for the manufacture of ordnance on a large scale will be a permanent and immensely valuable asset to the country. The Ordnance Department is to be congratulated upon the way in which it rose to the occasion, put in operation the vast organization and built the equipment above described.

Fitting the Shoe to the Soldier

(Continued from page 56)

the size by testing it with the shoe-fitting device—the set of metal blades. In reality this operation is employed in order to render it doubly certain that each man shall receive correctly fitted shoes.

Each of these small metal blades is marked with a shoe size—5½, 6, 6½ and so on. When a pair of shoes has been selected for the soldier, of the size indicated by the measuring device, the operator inserts in them a pair of the blades, of corresponding size, placing a blade in each shoe. The knob end goes forward into the toe of the shoe and the other end is sprung back into the heel.

The soldier then puts on the shoes and laces them up snugly. The blade in each shoe will lie flat and smooth in the bottom of the shoe under the stocking, and will follow perfectly the conformation of the arch.

The little knob in the toe end of the shoe occupies exactly the space which should be free space between the soldier's toes and the leather at the end of a correctly-fitted army service shoe. Even when the foot has been expanded, by the act of the soldier's walking and carrying his load, there should still be a certain space between the toes and the inside end of the shoe, because it is fundamental in the science of army shoe fit that under no circumstances should the ends of the toes be in contact with an obstruction of any sort.

Presence of free space ahead of the toes does not mean that the shoe is too long, nor that in the acts of walking, running or jumping the foot is likely to slump forward too far. If the shoe fits correctly, and is laced properly, the ball points of the shoe, and the restraint of the lacing and the "throat" of the shoe, will serve further to hold the foot in its rightful place.

The test by the shoe-fitting blades consists in the soldier's determining whether or not he can with comfort wear the new pair when these blades are in them and when he walks briskly about, climbs upon a platform, descends a steep ramp fitted with cross-cleats, and otherwise gives the shoes a tryout approximating some of the severe exercises involved in field work and marching. If in performing these experiments—which take place at the time of fitting—the soldier's toes press against the knob of the blade, a longer shoe is required.

Battleship Strength of the Five Leading Naval Powers

(*Continued from page 53*)

the "Kansas" class and the five ships of the "New Jersey" class. We have also eight ships of the "Maine," "Alabama" and "Kearsage" classes, mounting 12-inch and 13-inch guns.

It is considered that a battleship becomes obsolete after 20 years of service and therefore the "Iowa" completed in 1897, and the "Indiana," "Massachusetts," and "Oregon," built in 1895 and 1896 must be reckoned in the obsolete class.

Before leaving the United States Navy and passing on to the next three, we draw attention to the fact that because of the great size and power and resisting quality of our dreadnought ships, they form a fleet which under a single command is fully equal in strength and fighting power to a combination of the Japanese, French and Italian dreadnought fleets.

We wish, however, very emphatically to draw attention to the fact that our navy, strong though it is in dreadnoughts, is very poorly balanced. We have no fast modern scouts whatsoever, and these are absolutely essential in the strategy and tactics of modern naval warfare. We have six very fine battle-cruisers authorized and partly under construction. These should be pushed to completion, but we should immediately commence the construction of the 7,000-ton, 35-knot scouts of the 1916 program, or better than that we should lay down a larger number of smaller and more handy type of equal speed, but of say 4,000 or 5,000 tons displacement. Our officers who were with the British fleet speak enthusiastically of a 35-knot scout of about 4,500 tons displacement mounting five 6-inch guns on the center line, and we think it would be good policy for our navy to lay down as early as possible at least a score of these in preference to the 10 larger vessels. We have authorized the construction of 10 dreadnoughts, four of them of the "California" type and the other six to be of over 40,000 tons and carrying ten or twelve 16-inch guns. This program in common with whatever program Great Britain may have under consideration and those of the other naval powers will come under consideration by the peace conference with a view to fair reduction, on the basis of the respective requirements of the various countries concerned.

The Japanese Navy

During the war Japan has added six ships of the dreadnought class to her fleet. Four of these are battleships of over 30,000 tons displacement, each mounting twelve 12-inch guns and steaming at 22.5 to 23 knots. The other two are battle-cruisers of 27,500 tons, mounting eight 14-inch guns and steaming at 27.5 knots. She is also building a new battleship of 32,500 tons and 23.5-knot speed, designed to mount 10 15-inch guns upon which not much work has been done, construction being stopped for the period of the war.

Of predreadnoughts Japan has 12 of widely differing military value. Six of these are what might be called semi-dreadnoughts, inasmuch as in addition to their 12 guns, they carry a heavy intermediate battery of twelve 10-inch in the case of the "Aki" and "Satsuma," four 10-inch in the case of the "Kashima" and "Katori," and eight 8-inch on the "Kurama" and "Ibuki." The Japanese predreadnoughts are generally more modern than those of other nations, all of them having been built since 1900 and all having speeds of from 18 to 22 knots.

The French Navy

The French ships completed during the war are three of the "Bretagne" class, 23,500 tons; mounting ten 13.4-inch guns. The French had laid down five ships of the "Normandie" class of 25,250 tons, mounting 12 13.4-inch guns in three 4-gun turrets; but they had done very little work upon the ships when the war opened, and did practically nothing during the progress of the war. Hence, the French navy includes at present only the seven dreadnought battleships of "Bretagne" and "Courbet" classes.

Remembering that a dreadnought ship includes nothing less than 12-inch guns in its main battery, it will be understood that the five French battleships of the "Mirabeau" class which mount four 12-inch and 12 9.4-inch guns, cannot be considered available for the first line. Like the Japanese "Aki," the Italian "Vit. Emanuele" and the British "Lord Nelson" classes, these vessels must be reckoned in the predreadnought class which for the French navy includes a total of 11 ships. Of obsolete vessels the French navy possesses three.

The Italian Navy

Similarly to the French navy, the Italian navy had under construction when the war started some powerful dreadnoughts of which the keels had been laid but upon which all work was stopped during the war. These are the four ships of the "Colombo" class; 31,000 tons; 25-knot speed; mounting eight 15-inch guns. The five dreadnought battleships in commission are from 21,000 to 22,700 tons displacement and 22 to 23 knots speed. One carries a battery of twelve 12-inch guns, the others a battery of thirteen 12-inch guns, mounted in three 3-gun and two 2-gun turrets. It will be noted that neither the French nor the Italian navies have built any warships of the battle-cruiser type.

Deterioration in Ultra-Violet Radiation of Mercury Lamps

THE radiations from the quartz mercury-vapor lamp are being used extensively in accelerating photochemical actions, as a bactericide in sterilizing water, as a therapeutic agent, in dye-fading tests, and in other connections. The violet and ultra-violet rays appear to have, as distinguished from the infra-red, a marked effect in many of these activities. There has accordingly arisen among manufacturers of paper, dyes, cloth, rubber goods, paints, etc., a distinct need for a source of ultra-violent radiation of high intensity which does not decrease with use.

It is well known that the intensity of the radiation from quartz mercury-vapor lamps, especially as regards the ultra-violet component, decreases greatly with use. This decrease has been established qualitatively by several experiments, using physical, chemical and biological tests. But no exact quantitative data have been available showing the rapidity and the extent of the loss in effectiveness, as a function of the time of operation of the lamp.

Some months ago the problem was presented to the Bureau of Standards. In attacking it it was first necessary, as is so often the case in the investigations of this Bureau, to devise methods and instruments which would measure the deterioration quantitatively. The Bureau of Standards is quite in the habit of being the first to undertake a certain observation or measurement, and so is not at all dismayed to find that no accepted procedure is known for doing something that it wants to do. When it meets this situation, it just goes ahead quietly and invents a way, and, as often as not, a tool or instrument or whatever else may be needed.

In the present case it was found possible to measure the ultra-violet radiation with a thermopile and a yellow glass. Several makes of quartz mercury-vapor lamps were examined; none was found to possess any great advantage over the others in point of initial strength of the ultra-violet component. The total intensity of that component was found to decrease to one-half or one-third of its initial value after 1,000 to 1,200 hours service. A full account of the methods used and the results obtained is given in Scientific Paper No. 330 of the Bureau, just issued.


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